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C. F. MORGAN
1874

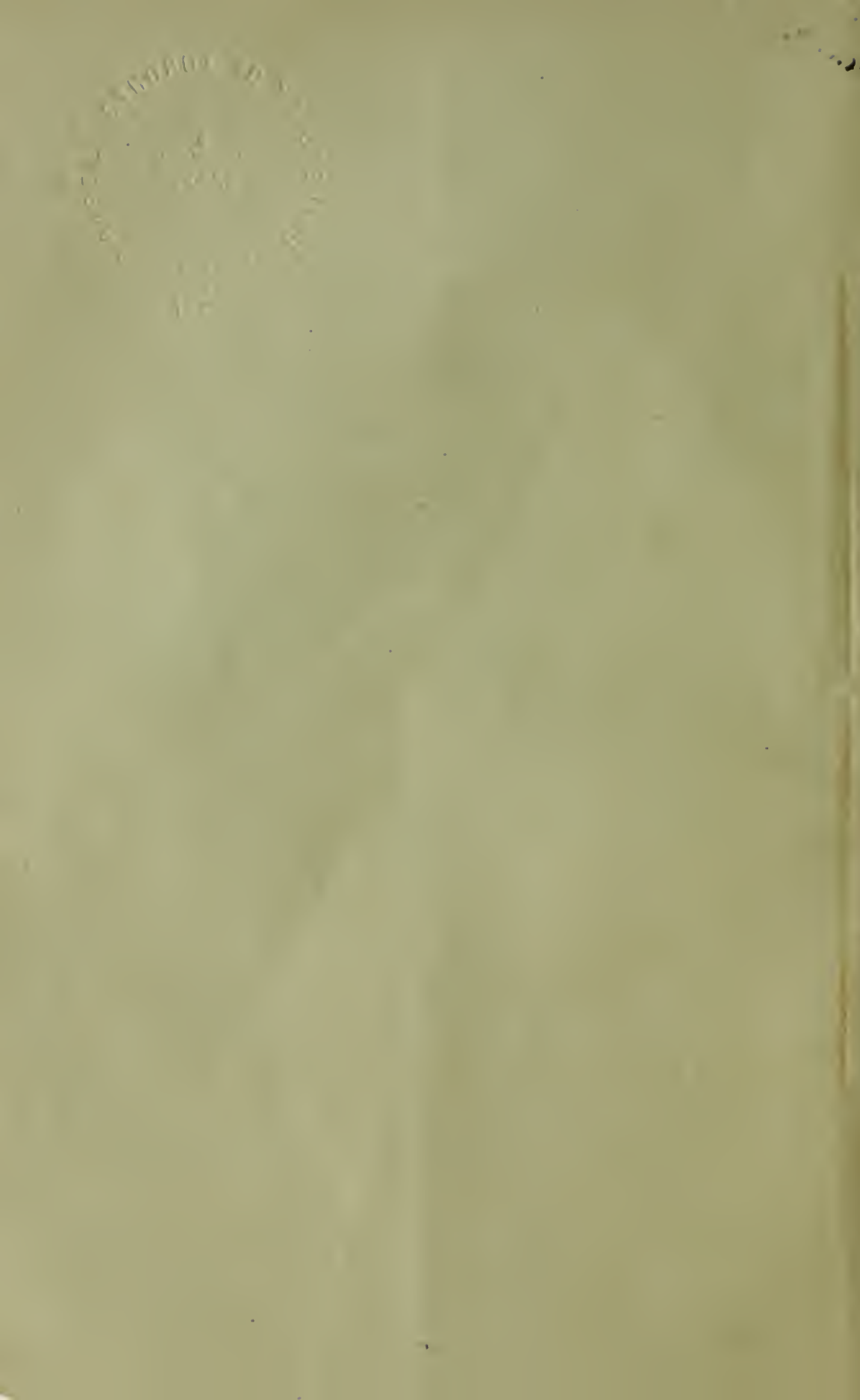
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- No. 2.—*On the Carboniferous Brachiopoda of Itaituba, Rio Tapajos, Prov. of Pará, Brazil.* BY O. A. DERBY, M. S., *Instructor in Geology and Palaeontology in The Cornell University*

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No. 1.

MORGAN EXPEDITIONS, 1870-71.

CH. FRED. HARTT, *in charge.*

Preliminary Report.

My Expedition to the Amazonas, in 1870, was undertaken chiefly for the purpose of studying the geology of the valley, and of examining the table-topped hills, which last had been referred to the Drift. I wished, also, to take into the field a number of scientific students from Cornell University, in the expectation that some of them, at least, might be stimulated to devote themselves to the life study of some branch of Natural History.

My funds consisted, in the first place, of the sum of \$500, generously placed at my disposal by a friend in New York city, whose modesty, I regret, will not allow me to give his name. This formed a nucleus, to which Col. Edwin B. Morgan, of Aurora, N. Y., one of the trustees of Cornell University, kindly added \$1,000, and Professor Goldwin Smith, \$500. The Syracuse High School contributed \$200, afterwards increased to \$500. Messrs. Garrison & Allen, of the Brazilian Mail Steam Ship Company, kindly gave passages, at half fare, for myself and party.

I was accompanied by my colleague, Prof. A. N. Prentiss, botanist, together with nine students of the University, and two others. We set sail from New York on the 23d of June, and arrived safely at Pará, spending a day at St. Thomas, in the West Indies, in collecting corals and other marine invertebrates.

At Pará we established ourselves in private quarters, on the edge of the forest in Nazareth, and spent a month in training, my boys occupying themselves in collecting excursions in the immediate vicinity, though trips were made up the Acará, and to Carapí, Vigia, and Marajó.

Dr. Abel Graça, the President of the Province of Pará, having placed at my disposition the little Government steamer, *Jurupensem*, Commandante Ledo, I ascended the Tocantins

as far as Trocará, where I took the ship's boat and continued up the river beyond the lower rapids, as far as the Cachocira do Guaríba, beyond which I did not think it advisable to attempt to go. I found the falls and rapids formed by reefs and masses of metamorphic rocks, slates, quartzites etc., probably of Silurian age, much disturbed and traversed by trap dykes, the valley below having been hollowed out of a heavy sheet of clays, that showed no signs of drift origin. Our Tocantins trip occupied a month, and was very productive in results. I made a careful geological and geographical reconnaissance of the region explored, and, with the aid of my young friends, gathered together a good collection of insects, fishes and other fresh water animals.

Returning to Pará by way of the Igarapé-ussú, I had an excellent opportunity of studying the geographical features of the low, marshy lands between the Tocantins and Pará. At the Capital, we delayed a few days; after which, with the same steamer, we made an excursion on the Amazonas and Tapajos, visiting on the way, the Lower Xingú, and exploring the Canal do Aquiri. We ascended the Rio Tapajos to Itaitúba, a little village about twenty-five to thirty miles below the Cachoeiras. I had no sooner set foot on shore, at this place, than I found the beach strewn with characteristic fossils of the Coal Measures. At Itaitúba, the Tenente Joaquim Caetano Corrêa kindly arranged for me a heavy *montaria* and a crew of Indians, for exploring the region of the falls. We then ascended with the steamer to the head of navigation, at the foot of the lower fall. Here I made up a boat party, consisting, besides myself, of Prof. Prentiss and four students, and sent the steamer back to Itaitúba to await our return, Messrs. Herbert Smith and Theo. Comstock being commissioned, with the aid of Messrs. Wilmot and Stanton, to explore the vicinity for Carboniferous fossils.

We found the river quite low, but, by dint of hard pulling, we succeeded in ascending several of the lower falls, when, finding myself in an extremely disturbed region, promising very few results on a hasty reconnaissance, I returned, to

make a careful survey of the Carboniferous rocks between the falls and Itaitúba. My assistants at the latter place met with extremely good luck in collecting; and Messrs. Smith and Stanton had the good fortune to find a very important locality on a little creek called the Igarapé de Bomjardim, where limestone beds crowded with silicified shells occur.

After a short stay at Itaitúba, spent in collecting fossils, we returned to Pará, where I gave up the steamer and divided up my party. Prof. Prentiss and Mr. Powers went south to Bahia; Mr. Derby, accompanied by Mr. Wilmot, examined various parts of the coast between the Amazonas and Pernambuco, making, especially in the vicinity of the latter city, an important collection of Cretaceous fossils. Mr. Barnard I commissioned to examine the Indian burial mound of Pacoval, on the Island of Marajó, to which my attention had been called by my friend, Sr. Ferreira Penna, a gentleman, who, since that time, has aided me in many important ways. Mr. Barnard obtained a small, but interesting collection of pottery which I have described in the *American Naturalist*. *

On my way down the Amazonas, I had left Messrs. Comstock, Smith and Stanton at Monte Alegre to await my arrival from Pará, when I proposed to explore the Serra of Ereré. I spent a month at the village of the same name, carefully going over the vicinity on foot, but as I have recently published in detail the results of my visit, I do not need to recapitulate them here. Suffice it to say that I did not find a trace of glacial action, the Serra of Ereré appearing to be composed of rocks of Palæozoic age, while the plain to the north was determined, by the discovery of numerous fossils, to be of Devonian age. My time was exhausted at Ereré, and I was obliged to return home, arriving at the University in December, with a large and very valuable collection.

While I should have done twice as much work if I had

* The Ancient Indian Pottery of Marajó, Brazil, Amer. Nat. Vol. V., p. 259. In the same volume, p. 139, I have published a short paper on Brazilian Rock Inscriptions; and in Vol. VI, p. 607, is a note on the occurrence of Face Urns in Brazil.

not been accompanied by a party, whose crudeness and want of training hampered seriously my movements, I do not regret the course taken. We had not been long in the field before it was easy to determine who of the party were fitted to become naturalists. Several of my young men did nobly and proved real assistants; others, as might have been expected, accomplished little or nothing. Mr. Herbert Smith gave himself heart and soul to his work and proved a most diligent and successful collector. Since his return he has devoted himself exclusively to Natural History, and, a few months ago, he returned to the Amazonas to pursue, under my direction, explorations which we began on our expedition of '70. Mr. O. A. Derby, one of my new students, did much excellent work, his observations on the coast being of especial value. He is now Instructor in geology and palæontology, in Cornell University. My photographer, Mr. Theo. B. Comstock, labored faithfully, but beyond his strength; and his health failing, he was obliged to return home. He has since devoted himself to science, and last year was the geologist on Col. Jones' expedition to the Yellowstone. Mr. Barnard did some good work. On his return he gave himself up to Natural History studies.—If to discover a new Carboniferous fauna will repay a journey to Brazil, of how much greater importance is the discovery of a new Naturalist! Had the expedition produced no other results than to have added four new men to science, I should have considered time and money amply well spent.

My own studies on the expedition were not confined to geological and physico-geographical work alone. All corners of time were given to ethnological research; and having been fortunate in securing intelligent guides, I was able to make very rapid progress in the Tupí language, to illustrate which, I began to collect materials for a grammar, dictionary, and chrestomathy.

From January to July, after our return, Mr. Derby and myself were engaged at the University in arranging and labeling our collection and in elaborating some of our results.

In one respect, fortunately or unfortunately, my first expedition had been a failure ; for the Serra of Ereré did not prove to belong to the system of the table-topped hills and I had not time to visit one of the latter. In July, 1871, I succeeded in raising enough funds to enable me to return to the lower Amazonas, and to take with me Mr. Derby as my assistant. The Museum of Ethnology, of Cambridge, Mass., through the kindness of Prof. Wyman, gave me \$500 for archæological collections, and Col. Morgan made me a donation of \$1,000, and in acknowledgment of his aid, the name of this last gentleman has been applied to the two expeditions. The High School of Syracuse donated \$300, and from other sources I made up the sum to about \$2,500. I have to acknowledge the important aid rendered me by Messrs. Jas. R. Osgood & Co., of Boston, Mass., in paying me, in advance, for a series of illustrated articles on the Expedition for "*Every Saturday*." On the suspension of that periodical as an illustrated paper, the firm has kindly extended the time of my contract ; and, instead of being obliged to write a series of popular articles, I have been able to devote myself uninterruptedly to the elaboration of my results in a strictly scientific form. To Mr. Jno. S. Clarke, of the above firm, I am under especial obligations.

Finding the yellow fever raging at Pará, I went immediately to Santarem, at the mouth of the Tapajos, where a few days were spent in general exploration and in photographing. Mr. Derby, accompanied by Mr. Steere, a graduate of Michigan University, who joined us at Santarem, made a visit to the farming establishments of the American settlers of the vicinity, while I made a trip to Taperinha to re-visit the great fresh-water Kitchen-midden, hastily examined on my former journey. Here, accompanied by Mr. Rhome, I made a very careful examination of the shell-heap, from which I obtained pottery, and a few bones, while on the site of an ancient Indian settlement on the bluff above, I found some interesting stone implements, pottery, etc. Returning to Santarem, we then, in company with Mr. Steere, went to Ereré, where we

remained a fortnight, going over the Serra and vicinity on foot, and photographing the more important points. We also made a foot journey to the Serra of Tauajurí, never before visited by an explorer. We then ascended the Tapajos to Itaitúba, where Mr. Derby and myself spent a month examining the Carboniferous rocks and collecting fossils, meeting with most excellent success. My health during the latter part of my stay at Itaitúba was not good, and I was confined to the house for several days; but I employed my time to good purpose in collecting material for the illustration of the Tupí, Maué, and Mundurucú languages. During the whole journey, I employed all leisure time with language work, or the collection of aboriginal myths.

Returning to Itaitúba, Mr. Derby made a trip to Obydos, and I spent some time in examining the vicinity of Santarem.

In the latter part of October I dispatched Mr. Derby to Pará, to make arrangements for an exploration of the Marajó mounds, while I remained at Praínha to visit the table-topped Serra of Parauaquára, to which I made a journey on foot from the Rio Marapí. I arrived at Pará, ill, to find Mr. Derby and Col. Beckley, an artist I had engaged to accompany him, also laid up. After considerable delay, in which, as usual, I occupied myself with language work and photography, I succeeded in getting Mr. Derby and Col. Beckley off to Marajó. I left Pará on the 6th of December, homeward bound, and Mr. Derby followed me a month later, bringing with him a valuable collection from Pacoval.

Since my return from the Amazonas, the working up of the results of the expedition has progressed as rapidly as my University duties and the lack of funds would allow. The crustacea of the expedition of '70 have been placed, for determination, in the hands of Mr. S. I. Smith, of Yale College, who reports it to comprise about sixty species, many of which are new. I hope that his report will soon be ready for publication. The radiates have been submitted to Prof. A. E. Verrill. The insects are being examined by Mr. J. H. Comstock and Mr. Theo. Mead, of Cornell Uni-

versity. Dr. Newcomb has already examined the fresh water shells.

As it has been necessary for me to devote myself, first of all, to the description of the antiquarian collections, I have been unable to do much more than superintend work in the other departments. The archæological material has been so rich that it has been very difficult to work out. New collections have constantly been coming in, and what I intended as a short report on the antiquities of the lower Amazonas, has grown to be a large volume on the antiquities of the whole Empire. In this work, now far advanced towards completion, I propose not only to figure and describe the objects that have come into my hands, such as stone implements, pottery, human remains, etc., but to give accounts of the kitchen-middens, burial places, rock inscriptions, etc. After a most careful, critical study of the ancient authorities, Vaz de Caminha, Thevet, Lery, Hans Stade, Ives d'Evreux, Pero de Magalhães, etc., etc., I shall endeavor to give a sketch of Indian life at, and immediately subsequent to the discovery and occupation of Brazil by the whites. I have not limited myself to the description of ancient life alone, but I have compared the manners and customs of the ancient Brazilian Indians with those of existing savage races, not only of that country, but also of other parts of the world. In connection with my studies of the Indian pottery of Brazil, I have investigated carefully the modes of manufacture of earthen-ware employed among savage races the world over. I have traced the method of building up a vessel by coiling up a rope of clay, from the United States to Chiloe, and, as the result of long research, I shall show that the manufacture of pottery, being a branch of cooking, falls naturally, everywhere among savage tribes, into the hands of woman, a fact of much importance, because of the intimate connection between the manufacture of pottery and the growth of decorative art.

The occurrence of beautiful grecques, scroll borders and other ornamental forms on the ancient Brazilian pottery, forms which, even in detail, exactly correspond with Old

World ornaments, led me to a critical study of savage ornament, and to a discussion of the origin and evolution of æsthetic art. I shall attempt to show that decorative *forms* give us pleasure, *primarily*, because of the muscular movements made in following them, and that, from the physical structure of the eye, certain elementary forms must naturally be evolved, whenever the attempt is made to please the eye with lines. I have traced out every step in the evolution of the various frets, and have shown how these angular borders give rise to curved forms of more and more subtle curvature; the law of *the survival of the fittest to please* determining the persistence of well constructed, beautiful ornaments the world over.*

The volume on antiquities will be illustrated by some fifty heliotype plates, representing several hundred objects. Its publication will necessarily be delayed at least until the coming winter, by which time, after another visit to Brazil, I hope to add very considerably to my material.

The arrangement of the mass of language material has gone on steadily, but slowly, from the lack of time to devote to the work. A short paper on the Tupí language was contributed to the Philological Society, at its meeting in '72, and has been printed in the Proceedings of the Society for that year. The myths have been arranged, and in part, discussed.† They will be found of more than ordinary interest because of the correspondences they exhibit with savage myths of other countries. Considerable progress has been made towards working up the geological and physio-graphical results of the Expedition, and short papers have been published in the Journal of the Geographical Society of New

* The results of my studies on Ornament were first brought out in a paper read before the University Convocation, at Albany, in August, '73, and which will appear in the Report of the Proceedings of that body for that year.

† To the *Aurora Brasileira*, a paper published by the Brazilian students in Cornell University, I have contributed two short mythological articles, *O Mytho do Curupira*, (22 de Outubro, and 20 de Novembro, 1873,) and *O Mytho de Tupán*, (22 de Março, 1874). These articles were published in Portuguese, for circulation in Brazil, in the hope of arousing an interest in the study of Aboriginal Mythology. A few copies have been distributed among American and foreign mythologists.

York,* the Bulletin of the Society of Natural Science of Buffalo, N. Y.,† and the American Journal of Science.‡

Under my direction, Mr. Derby has put the large collection of Coal Measures fossils into excellent order, working out hundreds of beautiful silicified shells from the limestone of Itaituba; and, after a critical study of the Brachiopoda of this locality, he will describe them in the second number of this Bulletin. I take this opportunity of expressing my obligations to Prof. Hall and Mr. Whitfield, of Albany; to Mr. Meek, of Washington; to Mr. Alex. Agassiz and Prof. O. H. St. John, of the Museum of Comparative Zoölogy, and Prof. Marcou, of Cambridge, Mass.; and to Prof. Marsh, of Yale College, New Haven, for the assistance they have rendered my assistant in his studies. Mr. Derby will continue work on the Coal Measures fossils of the Amazonas, with the intention of monographing the whole fauna.

Mr. Rathbun has, under my direction, prepared descriptions of the Brachiopoda of the Devonian of Ereré, which were published in the Bulletin of the Buffalo Society of Natural Science.§ Since then he has determined the Lamellibranchs and Gasteropods of the same locality and formation, and a report upon them is ready for the press. He has also recently been engaged at the Museum of Comparative Zoölogy in working up the collection of Cretaceous Lamellibranchs collected by Mr. Derby near Pernambuco.

I propose to publish the results of the two Expeditions in the following volumes:—

I. *Brazilian Antiquities*—about 500 pp. 4to, with about 50 heliotype plates and many engravings. MS. nearly ready.

II. *Geology and Physical Geography of Lower Amazonas*.—500 pp. 4to, with about 50 plates and maps. About 150 pp. ready for press.

* Recent Explorations on the Valley of the Amazonas, with map, Jour. Amer. Geol. Soc. of N. Y., 1872, p. 231.

† Contributions to the Geology and Physical Geography of the Lower Amazonas; The Ereré-Monte-Alegre district, and the Table-topped Hills, op. cit. Vol. I, p. 201.

‡ Amazonian Drift, Amer. Jour. Science, 1871, p. 294.

§ On the Tertiary Basin of the Maraion, Amer. Jour. Science, Vol. IV, July, 1872.

§ Richard Rathbun, On the Devonian Brachiopoda of Ereré, Prov. of Pará, Brazil. Bull. Buff. Soc. of Nat. Sci., Vol. I, p. 236.

III. *Mythology of Brazilian Indians*. About 300 pp. 4to. MS. nearly ready.

IV. *Grammar, Dictionary and Chrestomathy of the Tupi Language, Ancient and Modern*. 400 pp. MS. nearly completed.

V. *An Album* of about 100 Photographic Views, illustrating the country, people, etc., of the Lower Amazonas. The views will be accompanied by about 100 pp. of text.

I hope this summer to return to Brazil to continue my explorations. My principal objects will be to review my work done several years ago on the drift deposits of the neighborhood of Rio ; to make a reconnoissance of the gold and diamond region ; and to explore the kitchen-middens of the vicinity of Rio and Santos, and the burial mounds of Marajó for antiquities.

[10]

Report of a Reconnoissance of the Lower Tapajos
BY CH. FRED. HARTT.

Among the rivers of Brazil the Tapajos ranks as the sixth. It is formed by the union of the two considerable rivers, the Juruéna and Arínos, which take their rise near the southern edge of the great Brazilian plateau, the former in Lat. $14^{\circ} 42' 30''$ S., and Long. $60^{\circ} 43'$ W. from Greenwich; the latter 15 leagues east of the Villa do Diamantino, in Lat. $14^{\circ} 24' 30''$ S., and Long. $58^{\circ} 2' 45''$ W., from which point to the Amazonas the main river Tapajos follows substantially a N.N.E. course.

The headwaters of the Rio Preto, one of the branches of the Arínos, are so close to those of the Paraguay, that canoes have passed by portage from one to the other, and Chandless states that, when he was in Diamantino, a canoe that had ascended the Tapajos from near Santarem, laden with a cargo of 1500 arrobas, crossed over the water-shed and descended the Paraguay to Villa Maria.*

Maps usually represent a range of mountains running from east to west through western Brazil, separating the headwaters of the Paraguay and Guaporé from those of the Tapajos, but, as I have shown in my work on the Geology of Brazil, no such serra exists. Every traveler has described the western part of the plateau of Brazil as a great elevated plain, without a mountain range. Chandless says distinctly that it is simply a high table land, or chapada, that varies but little in its general elevation, though deeply cut through by river valleys, and often descending abruptly to the lower lands, which appear like a sea with bays and coves. Castelnau has described it in the same way. Nevertheless, this mythical mountain range continues to be represented on the best maps of Brazil, simply because map-makers think that, between the great basins of the Amazonas and the Paraguay, there must of necessity be a chain of mountains.

* Penna. Região Occidental da Provincia do Pará, Pará, 1869, p. 148.

The Arínos and Upper Tapajos are navigable only by boats, light enough to be carried by portage around the falls and impassable rapids, which are so numerous that the ascent of the river is accomplished only with very great difficulty, the journey from Santarem to Porto Velho at the head of navigation on the Arínos, a distance of about 1,200 miles, consuming about three months, though the descent may be accomplished in as many weeks. So exceedingly difficult is the navigation of the Tapajos, that the commerce between Cuyabá and the Amazonas is limited to a few boats, that descend every year to trade in guaraná, a drug of which the Cuyabanos are very fond, and which is manufactured only by the Maué Indians of the Amazonas. It is useless to think of navigating the upper river by steam, and perfect nonsense to talk either of destroying the falls or of making canals around them. Matto Grosso must seek some other channel of communication with the Amazonas than the Tapajos.

In 1861, the river was explored geographically and mapped by Mr. Chandless, but the country through which it flows is still virgin field for geological research.

In this little paper I shall confine myself to a concise statement of the more important results of a reconnoissance made of the Tapajos, from the lower rapids to the Amazonas. In 1870 I ascended the river as far as the Cachoeira of the Apuí. I was desirous of going farther, but the disturbed metamorphic region, in which I found myself, did not promise good results on a hasty examination, and I thought it best to devote my time to a study of the Carboniferous rocks of the vicinity of Itaitíba.

From the entrance to the rapids, up to the Apuí, the rocks consist of red quartzites and other metamorphic strata, much disturbed, and broken through by immense dykes of porphyry and trap, the whole undoubtedly of pre-Carboniferous age. This region was once, I believe, overlaid by Carboniferous rocks, and very probably also by Tertiary (?) deposits, but these have been denuded away by the river, which has cut for itself

narrow, irregular channels through the hard rock below, channels which are often choked by dykes and masses of igneous rock, giving rise to rapids or very low falls, which of course disappear during the *enchente* or annual flood.

I found the region of the rapids to be irregular, rather low, and heavily forested down to the level of the *enchente*. Below this, the banks of the river are composed of sand or bare rocks, both of which, here and there, support trees, whose gnarled roots, especially among the rocks, are often washed bare, adding, as among the rapids of the Tocantins, to the picturesqueness of the scenery. Conspicuous among the trees of this shore belt is a species of *Psidium* called *Goyabarána*.

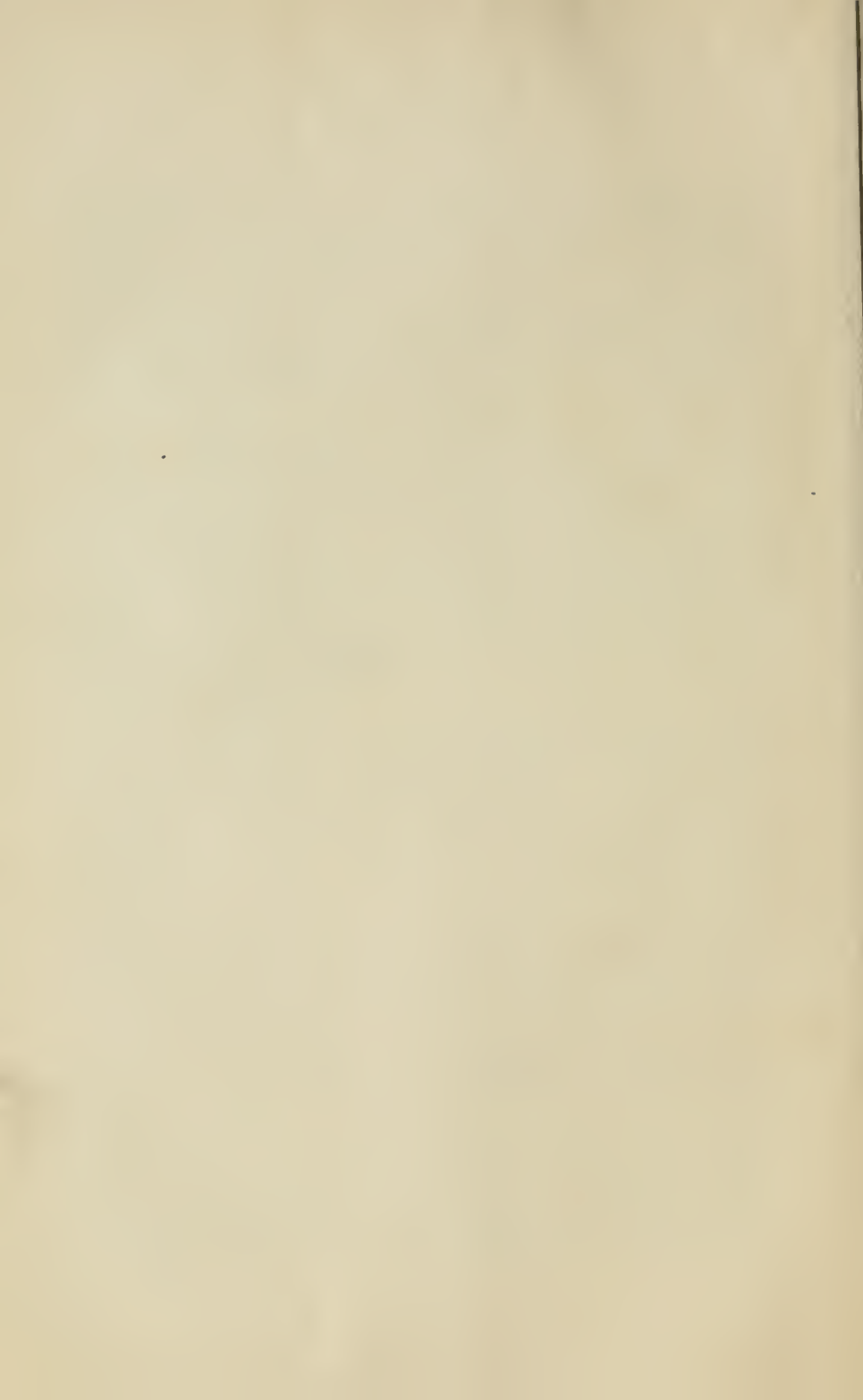
The Cachoeira of Apuím (Apuhy') is situated, according to Chandless, in Lat. $4^{\circ} 32' 0''$, Long. $55^{\circ} 54' 23''$, and is distant about 25 miles from Itaitúba. Here the river is divided into two main channels by an islet, and the fall just mentioned is on the western of the two. At the Apuím, at low water, the river is confined to very narrow, rocky channels, through which it rushes with great violence. The only fall I saw was an abrupt descent of about five feet, which, however, does not completely stop navigation, for it may be passed by empty boats. In the vicinity, two large dykes of trap are exposed, one of which is much cut up by pot holes. Here, as elsewhere among the rapids, the rocks are sometimes covered with a smooth, black, often semi-transparent, varnish-like glazing, like that of the rapids of the Parahyba do Sul, or of the Jequitinhonha. Prof. Schaeffer, of the Chemical Laboratory of Cornell University, has kindly examined this coating for me, and reports it to be largely composed of manganic oxide. Humboldt has already called attention to a similar coating on the rocks of the falls of the Orinoco. The water of the Tapajos, in the region of the rapids, is remarkable for its exceeding limpidness and transparency, and for its beautiful green tint, which surpasses that of the water of the Tocantins. Below the rapids, the color and transparency of the water are not seen to so great an advantage

when it is agitated. The Tapajos retains its purity, during the dry season, quite down to the mouth of the river, where it becomes somewhat soiled by the influx of Amazonian water, through the influence of the tide. By the side of the turbid waters of the main river, those of the Tapajos appear black, and hence, it is said, was derived the name Preto, applied to the river. This black appearance of the water is totally different from that of the Negro or Peruhype. I may add here that, even in the region of the falls, where the water appears so very pure and inviting, it is far from being wholesome, and its use is likely to give rise to diarrhœa and fever. This is probably owing to the fact that the water stagnates in the side channels and becomes poisoned by decaying vegetation, this poisonous water slowly escaping into the main stream.

On the eastern channel is a heavy rapid called the Caboleiro, which, in dry times, must be quite impassable. Just below the union of the two channels is the Cachoeira do Cuatá, a rapid of no importance.

On the western bank of the river, near this last rapid, there is an exposure of a very fine grained, compact, heavy, rock, breaking with a conchoidal fracture. It is of a dark, brownish grey, or chocolate color, and full of minute green grains, whose mineralogical character has not yet been satisfactorily determined. The fresh fracture presents no signs of lamination, but the weathered surface shows what appear to be structural lines, as if the rock were originally stratified. Another specimen from the same locality is much more coarsely grained, presenting more the appearance of an igneous rock, but both are, however, probably metamorphic.

I have given, opposite, a rough map of the part of the region of the falls examined, with the river extending as far down as Itaitúba. It is nothing but a sketch and does not pretend to be accurate. The river has never been surveyed, and, occupied as I was with geological and zoölogical work, I had no time to make an accurate map. Rambling among rocks and in the forest, in the region of the rapids, it was impossible to form any clear idea of distances, but I should



estimate that, with the September waters, one could make the journey to the Cuatá from the entrance to the falls, by canoe, in a day. We found the river confined to narrow, rocky channels, and very low, but by no means at its lowest stage. The shores were usually rocky or sandy, and indicated that, at high water, the river rose to a height of thirty or more feet above the level at which it stood at the time of my visit.

On the same page with the above map will be found a rough sketch-map of the vicinity of the so-called Cachoeira do Maranhão Grande, an interesting locality.

The Canal do Freichal, *F*, is a series of rapids, formed apparently by stratified rocks dipping up stream, and quite impassable at low water.

Between the Freichal and the Maranhão Grande, *MG*, is a hill about 250 feet high, probably composed of porphyry. The Maranhão Grande is simply a rapid, formed by the constriction of the stream by a very heavy ledge of porphyry, which extends northward for some distance along the eastern bank of the river. The canal thus formed is about 200 feet wide, and apparently very deep, the water, at the time of my visit, pouring heavily through, broken only by whirlpools. The whole presents, as I am informed, no serious impediment to canoe navigation at any stage of the river. Behind the porphyry ledge is a channel called Maracaná, said to be navigable when the waters are high. From the point formed by the hill above mentioned, there runs obliquely down stream, towards the right bank, a heavy dyke of porphyry, broken into narrow islets, as is well shown on the sketch map. The river channel is probably worn out of the stratified rocks.

From *a* to *b* the great dyke skirts the eastern side of the river, forming a narrow ridge, about 20-30 feet high at low water, and presenting an abrupt, wall-like face towards the stream. The material is a rather fine grained, red porphyry, much broken by joints. The top of the ridge, near the southern extremity, is much worn, and large pot holes have been excavated in it. In places the rock is very

smoothly polished and glazed. At *c*, just across the channel of Maracaná, the porphyry is divided by vertical cracks, into large, thin slabs giving to the mass a stratified appearance. In a specimen brought away with me, the interior, as shown by a fresh fracture, is composed of a dark, chocolate-colored, flinty, feldspathic paste, through which small crystals of dark red feldspar, and rounded quartz grains are disseminated. The specimen is interesting because it shows four surfaces that have been exposed to the action of water, from which decomposition, through loss of alkalies and oxidation of iron, has extended inwards. One surface, longest exposed to the water, is covered by a jet black, opaque glaze, of rather dull lustre, but, on other surfaces, this glaze is very thin and translucent, like a brilliant brown varnish.

The porphyry of the dyke *g g g*, judging from a specimen obtained from its point of junction with the bank of river, is much coarser than that of the dyke just described, and the paste is lighter in color and more granular. The quartz grains and feldspar crystals are also much larger, and there is a considerable admixture of a green mineral now apparently decomposed. The feldspar has been examined for me by Prof. Schaeffer of the Chemical Laboratory, and found to contain both soda and potash. One analysis gave $K_2O=7.570$ and $Na_2O=6.208$. The quartz grains are glassy and rounded, having probably been formed as crystalline *blebs*, during the solidification of the rock, as has been suggested by Jukes to have been the case in certain felstones.*

Crossing the river from *a* to *f*, we find the following section † along the river bank, going north. At *a* is an exposure of a very hard, dark red quartzite, which dips strongly up stream, the same rock apparently showing itself, at intervals, as far as the Freichal. Just below this exposure is a heavy dykelike mass, *b*, of a very fine grained, dark colored, crystalline rock. Several hundred feet farther down, the quartzite, *c*, appears with a dip of 15° – 20° towards the S. E. The rock

* Jukes and Geikie, Manual of Geology, p. 109.

† See map opposite pp. 14.

is well stratified and the surfaces of the the beds are often beautifully ripple-marked. This quartzite continues for some distance, with the same dip, when, according to my note-book, a compact, red rock, *d*, spotted with green is exposed. The stratification is not apparent, and, as the specimen brought away has been mislaid, I am unable to determine whether the mass is a dyke or not. About 200 feet farther down, the red quartzite, *e*, appears with the same dip as before. At *f* is a heavy dyke (?) of a bright, brownish red, fine grained rock composed of feldspar, through which are distributed small grains of clear quartz. Beyond this is a heavy exposure of the red quartzite, which is regularly stratified, the strike being N. 30° – 45° E., and the dip 15° – 20° towards the S.E. The rock is of a warm, brownish-red color, exceedingly compact, and mainly consisting of a red, amorphous mass in which are crystals of feldspar, together with minute quartz grains. The lamination is very obscure. No traces of organic remains were observed. At this last exposure, the ripple-marking was beautifully exhibited on the broad surfaces of the exposed strata. There can be no question as to the sedimentary origin of these quartzites, but I am in doubt as to whether the dyke-like masses are not really interstratified beds of the same metamorphic series. So far as the great porphyry dykes are concerned, their direction shows conclusively that they are of igneous origin. As to the age of the above beds, we can safely claim only that they are older than the Carboniferous, since they certainly were disturbed and metamorphosed before the deposition of the Coal Measures of the Itaitúba series.

Below the Freichal and Maranhão Grande the river forms a lake-like expanse, about a quarter of a mile broad, and apparently very deep. The country on each side is hilly and forest-clothed. The locality is extremely picturesque, and would be very enjoyable, but for the plague of flies, which, as among the rapids of other Brazilian rivers, and in the region of the falls of the Orinoco, is at certain seasons, well nigh unendurable. By day prevail the *piúns*, a species of *Trombidium*, which, as Prof. Riley informs me, passes its larva stage

in rapidly running water in rocky places, the insect being, therefore, confined to the neighborhood of the rapids. Its bite is as painful as that of the Canadian black fly, but, as the puncture does not bleed, a tiny drop of blood collects under the skin. This soon dries, forming a dark point, and the skin of voyagers among the rapids, on all exposed parts of the body, soon becomes blackened. The bites are likely to become inflamed and give rise to bad sores. I have never seen a *piú*m at Itaitúba. These pests disappear at night, and, for a change, mosquitoes take their place.

To the zoölogist the region of the rapids is extremely interesting. The rocky shores abound in fresh water shells, principally species of *Ampularia*, *Melania*, and *Ancylus*, while species of *Castalia*, *Anodon*, *Hyria*, etc., are common in muddy and sandy places. Sponges with silicious spicules grow on the rocks, and pebbles are often encrusted by a delicate, creeping bryozoön. Among the fishes are large rays, which put one in mind of the sea, as also do the porpoises found gamboling about among the rapids; but the narrowness of the channels, and the near, wooded banks, notwithstanding the sea-green water and the general marine aspect of the river life, prevent the illusion one constantly labors under in the region of the rapids of the Guaríba on the Tocantins, where the deep, quiet coves, walled in by high rocks hoary with seaweed-like *Castelnauvias*, the green water that one forgets to drink when thirsty, the *Natica*-like *Ampullarias* and *Cerithium*-like *Melantias* clinging to the rocks among the sponges, the crabs and shrimps, the skates and gaily-tinted fishes, all strongly suggest the sea, and the illusion is heightened by the sudden leap of the dolphins, and the cry of gulls whirling overhead.

At the northern end of the Maranhão Grande a broad belt of porphyry extends across the river, which, on reaching it, divides into two narrow, sinuous, rocky channels that enclose a large island. The easternmost channel, that which I examined, is called the Maranhãozinho. The other is said to receive the waters of a little river called the Tracuí. Across

the eastern channel, just at its head, extends an irregular line of rocky islets covered in part with *goyába rána*. Between these the river, at the time of my visit, fell abruptly about two feet, forming a cachoeira which was easily passed by our boat. This fall is called the Cachoeira do Maranhãozinho. Just at the fall is a very compact, fine-grained, dark brownish gray, trap-like rock, containing minute crystals of iron sulphide. In this rock is a dyke of coarsely crystallized hornblendic trap.* Just below the fall I found a crystalline rock composed almost entirely of light red feldspar with a few small quartz grains. The rock thence to the end of the channel is red porphyry, consisting of an amorphous, brownish red, feldspathic paste, in which are embedded crystals of feldspar and more or less clear quartz, some varieties being so quartzose as to resemble a sandstone.

Below the region of the rapids are a few, small, rocky islets, immediately to the north of which is the long, narrow, and low island of Goyána, which might, from a distance, be supposed to be of alluvial formation. It is, however, composed of Carboniferous strata. North of this island the river widens out to a mile or more, increasing in breadth towards Itaitúba, where its width must be about a league. The country between the rapids and Aveiros consists of Coal Measures rocks lying quite horizontally, and overlaid by a heavy sheet of clays, probably Tertiary, which, on the eastern side of the river, extends to the Amazonas, but does not reach so far north on the opposite side. Out of these beds the Tapajos has cut a very wide valley. This, in comparatively recent times, was an estuary, from which, owing to the rise of the land, the sea, but not the action of the tides, has been excluded. This estuary, which the pure waters of the Tapajos are unable to silt up, is now converted into a lake, the water being dammed back by the Amazonas, which has silted up the side of its own valley, contracting the mouth of the Tapajos as we shall presently see. The Tapajos, like the Tocantins and Xingú, has always

* The rocks collected in the Morgan expedition have not yet been studied. I propose to have them carefully examined before my final report is published.

been considered a very large river, because of the immense width of its lower reaches, but, at the falls, one is surprised to see how small the stream really is. At ordinary times the river contains but little water, and the expanse below the rapids is exceedingly shallow.

The upper end of the Ilha de Goyána is rocky, but I had no opportunity of examining it. Near the house of Sr. le Verger, beds of a soft, moderately coarse sandstone, white and mottled with red, are exposed. In this rock are curious, irregular, ferruginous bands, and markings that resemble worm burrows, but I saw no organic remains. The same sandstone, much decomposed, makes its appearance a short distance below, on the same side of the island; and, on the bank of the river in front of le Verger's establishment, a similar rock is seen, here bored full of deep, cylindrical burrows, forming the nest of the Acari fish, a species of *Goniodont*.

A little below the port of le Verger, and on the same side of the island, are exposed horizontal beds of soft, white and red sandstone, several layers of which are remarkable for being traversed by numerous, perpendicular, pipelike concretions of ironstone, which, together with similar structures from other parts of Brazil, I propose to describe fully on another occasion.

Over these beds is a layer of chert nodules containing marine fossils characteristic of the Coal Measures, and similar to those of Itaitúba. Looking up the river from a point just below the Island of Goyána, the hills of Cuatá and Maria Louisa, in the region of the rapids, appear to rise considerably above the general level of the country, presenting rounded outlines. The right side of the river is, for some distance, alluvial and very low, with a sort of low table-land, or chapada, rising beyond. On the left side the land rises, appearing to form a series of low chapadas, extending to the above mentioned hills.

Barreirinha is the name given to a bluff and sitio on the left bank, a short distance below the island. The cliff is formed by the cutting away of the side of a hill about 80 feet high,

which, to the west, slopes downward abruptly to a little valley, in which is a pond full of magnificent *Victoriæ*.

Carboniferous rocks are exposed in the bluff, and I made out the following section, the beds being given in ascending order.

1. The lowest beds seen consisted of a soft, leaden blue shale, containing septarian concretions, the whole much decomposed on the surface; about 5 feet exposed.

2. Dark brown, ferruginous, dolomitic rock, more or less decomposed, probably concretionary, about one foot in thickness.

3. Bluish shale, well laminated, decomposed, with numerous septaria, which are often three or more feet across. These are rounded, flattened, or irregular in form, and usually lie with the longer diameter horizontal. They have commonly an organic nucleus, which, in most cases, as far as I have observed, is an ichthyodorulite or some other fragment of a fish. Of the many specimens of these remains collected, none are in good condition, for, in the cracking of the septaria, they have been badly broken up. The rock in these concretions is usually of a dark bluish tint, colored by ferric carbonate, and often beautifully variegated by the oxidation and discharge of iron along the cracks. The rock from which the iron has been discharged is light gray or delicately mottled. Of these and other mottled and variegated rocks I propose to treat more extensively in my Final Report. Near the upper part of this bed of shales I found a fragment of a *Lepidodendron*,* but the species is undeterminable. These shales have an estimated thickness of about 40 to 50 feet.

4. Over the blue shales, but badly exposed and much decayed, are soft, white shales, with thin, ferruginous bands.

Over the denuded surface of the white shales is a bed, about 5 feet thick, consisting of fragments of sandstone, quartz pebbles, etc., apparently deposited under water, as the flat fragments appear to be arranged horizontally. In this bed I

* The fossil plants collected near Itaitúba, have been referred to Dr. Dawson for examination.

obtained fragments of carbonized wood, but it was impossible to determine whether they were of the age of the deposit or not. The soil overlying this bed consists of a reddish, sandy clay, containing loose pieces of sandstone, pebbles, etc.

The Carboniferous beds in this section appear to be quite undisturbed. The only marine fossil collected at this locality was an *Orthoceras*, found in a septarium. This is the only specimen of this genus so far observed in the Carboniferous rocks of the Tapajos; but unfortunately the species is not determinable.

Looking off to the south-eastward across the river from the top of the bluff, the country for some distance appears to be very low, with a range of higher land beyond. A little to the west of south, a high hill is seen in the vicinity of the cachoeiras, with, just to the west, another hill that appears to be flat topped.

At Barreirinha the *saúba* ant is a perfect plague, and destructive beyond measure. I saw a number of small orange trees from which they had cut off, not only the leaves, but even the tips of the branches and spines. These last they found so difficult to sever that many were only girdled. These same ants cut also the pinnules of the Inajá palm, fragments of which I saw lying at the mouths of their holes. The ground was covered by a perfect net-work of their paths, over which a constant procession was moving.

About a mile below Barreirinha, and on the same side of the river, I found bluish shales similar to those of the locality just named. A little farther on begins a line of low, perpendicular cliffs of finely laminated, soft, dark colored shale. The only fossil obtained was a species of *Spirophyton*.

In the lower part of the bluffs, near the river, were many septaria, embedded in the shales, some as much as five feet in diameter. The bluffs extend along the river for a considerable distance, terminating near the southern end of a large, low island called Uatapucurá.* On the opposite side of the river the higher lands extend down to the river, forming a con-

* Near by is the channel *Uatá-pukú*, which, in Lingoa Geral, means *the long walk*.

siderable bluff covered with foliage. These high lands appear to have an elevation of about 200 feet.

Below the bluff, and on the same side of the river is the little Igarapé do Uatapucurá, on which, a few years ago, an American constructed a well-appointed saw-mill that has never been brought into operation.

Below the Igarapé, on the same bank, I found exposures of Carboniferous rocks, which showed in ascending order as follows :—

1. Greenish shale like that of other bluffs already described.
2. Coarse, black, well laminated shale, affording spore cases of *Lepidodendron* (?). In this bed septaria are numerous and interesting, because of the radiating crystals of calcic carbonate embedded in their mass.
3. Coarse, irregularly laminated, green, white and red, arenaceous shales, with abundant worm tracks, trails of gastropods (?) and nodules of iron pyrites.

These beds, of which I did not determine the thickness, have a slight dip down stream and presently go under water. They are then seen to be overlaid by about five or six feet of fine, soft, well laminated, black shale, with spore cases of *Lepidodendron*, and numerous, very large, septarian concretions. The interior of these masses is usually composed of a reddish brown, compact, very heavy rock, which breaks with a velvety fracture, and shows by reflected light that the mass is pervaded by the crystalline structure due to dolomite. Prof. Schaeffer reports that a fragment of a similar rock contains dolomite and ferric carbonate. In some of the septaria I found sandy layers with fish teeth. On the outside of these masses is often a concentric coat of ironstone, which sometimes exhibits beautifully the cone-within-cone structure.

The shales containing septaria, just described, are overlaid by a foot and a half of soft, blue clay, or decomposed shale, over which are dark colored, finely laminated, arenaceous shales with white layers. Further on, the bluff ends, and the strata are much broken up, and filled in with iron ore.

Here I found thick flakes of red ironstone, not seen in place,

but apparently derived from a recent mottled clay. These afforded beautiful impressions of dicotyledonous leaves, resembling those collected by Prof. Agassiz at Tonantíns and by myself at Praïna.

A little farther down the river, and on the same side, is the Morro de Saraiva, which shows a very steep, bluff face about 100 feet high, in which, at the top, are exposed beds of green shale full of septaria. A little farther down and nearly in the middle of the river, is the little island of Itacaapaám, about 15 feet high, composed of a brown, ferruginous sandstone.

A short distance below the island, on the left bank of the river, commences a long line of very low limestone bluffs, called the Paredão.* The limestone beds are quite horizontal and are part of a great sheet extending along that side of the river to, and beyond Itaitúba. In these bluffs I saw only a thickness of about 15 feet of limestone exposed. The rock consists of a compact limestone, more or less arenaceous and impure, and full of fossil shells, principally Brachiopods, which are usually silicified. The color of the rock varies from nearly white to light gray or brownish. Over the limestone is a bed of coarse, white sandstone. In 1870 I had but a very short time in which to examine this locality, and I did not find it so promising in fossils as the immediate vicinity of Itaitúba. I had intended to revisit it in '72, but my illness, together with the difficulty of obtaining a boat, made it impracticable. Very likely, when the water is at its lowest, the Paredão may be found to be a good collecting ground.

The country on the left bank of the river at the Paredão, and for many miles farther down, is very low, and, at the village of Itaitúba, it is only just above the reach of the annual flood.

Two or three miles above Itaitúba and on the same side of the river, the little Igarapé de Bomjardim enters the Tapajos. In the lower part, this little stream has hollowed its channel out of the limestones, which not only crop out here and there

* Paredão, literally a large wall. On account of lack of type I have been obliged to use the circumflex instead of the til.

on its banks, but are exposed on the surface of the ground. On the southern bank of the Igarapé, and just above its mouth, the limestone is quarried and burned in a kiln near by, one of the layers furnishing a very good quality of lime, which is sent down the river to Santarem.

At this locality the limestones are beautifully exposed, both in a quarry and natural section. The upper bed is composed of a compact, light colored, impure limestone, with but few fragmentary fossils, and worthless for lime. Below this is a purer limestone, almost white in color, containing fossils. This is readily dissolved away by the Igarapé at high water, and it is picturesquely honeycombed with little grottoes. Near the top of this bed is an irregular band of dark bluish chert containing fossils, among which are *Productus*, *Bellerophon*, etc. The whole thickness of the section exposed at dead low water at this locality is probably not more than 10-15 feet.

Mr. Babcock, of the Chemical Laboratory, reports an analysis of this limestone, as follows:—

Silica and insoluble matter	3.65
Lime	52.61
Carbonic Acid	42.79
Iron and Aluminum	.83
Magnesia	trace.

This analysis shows that the limestone is of very good quality and it accords with the reports of those who have used the lime.

A few hundred yards further up, there is another quarry and kiln on the opposite side of the Igarapé; and a little beyond, on the same side, is one of the most interesting palæontological localities I have ever examined. On the bank of the Igarapé where the rocks crop out, the purer limestone has been dissolved out by the waters of the Igarapé during flood, leaving the uppermost, hard, impure bed projecting, forming several little grottoes, whose roofs, when first visited by my assistant, Mr. Smith, in '70, were literally studded with beautiful silicified shells, quite disengaged from the matrix, and ready to drop into the hand. The whole col-

lection has been carefully removed to our Museum at Cornell and, with other material worked out from the solid limestone, and collected from the vicinity of Itaitúba, is hardly to be equaled in its richness in specimens showing structural details.

The upper bed of limestone, 5 or 6 feet in thickness, is light grayish brown in color, compact, hard, and full of scattered fragments of silicified fossils. The lower part of the bed, or, more properly, a parting between it and the bed below, is impure, more or less silicious, and packed full of perfect, silicified shells, among which those of Brachiopods predominate. Sometimes the shells are perfectly silicified, but when thick, as is often the case with *Spirifer camerata*, *Orthis Morganiana*, Derby, and other species, the silicification, extending inwards from both surfaces, has not reached the middle, which, in developing the specimens with acid, is usually dissolved out. Specimens of this kind will be figured in the plates illustrating Mr. Derby's paper, in the second number of this Bulletin.

In the limestone, and associated with the shells, are long, tortuous, irregularly cylindrical, root-like, silicious casts, perhaps of fucoids.

The beach between the Igarapé and Itaitúba is strewn with fragments, mainly silicious, derived largely from the decay of the Carboniferous rocks, and often furnishing beautiful fossils, but there is, unfortunately, no good exposure of the beds, even at Itaitúba. At one point near Itaitúba, a few feet in thickness of red and white sandstones like those of the Ilha de Goyána are seen. Above the sandstone is a layer of gravel, over which is a red clay.

In the dry season, a broad, pebbly beach borders the river in front of Itaitúba, and the shore is strewn with more or less decomposed chert nodules, and silicious fragments washed from the Carboniferous rocks, and often full of fossils. Excellent specimens of Brachiopods may be collected lying loose on the shore, and from the clay near the top of the beach I have picked out great numbers of silicified shells, orthids,

spirifers, etc., together with the spines of a species of *Archæocidaris*.

The beds are, however, nowhere well exposed, and, when they do crop out, they have been so decomposed that nothing can be made out of them. Lines of large chert nodules, often affording excellent fossils, are found, apparently in place, but embedded in clay.

Strewn over the beach at the lower extremity of the village, are numerous, large, loose, boulder-like masses of a white or greenish silicious rock, which at first resembles a sandstone. These have, without doubt, been rounded in part by decomposition, but it seems to me very doubtful whether they have ever formed part of a continuous, homogeneous sheet. On close examination, the rock is seen to be almost entirely composed of little quartz crystals, and to contain moulds of shells in abundance; these moulds being usually empty, or, at most, lined with minute crystals. This rock, on one hand, passes into a very compact variety resembling quartzite, and, on the other, into an amorphous chert. The masses we examined appeared to be much more solid and compact in the centre than near the surface, where they were usually more or less reddened and decayed.

This rock appear to have been formed, in some way, by the replacement of a limestone by quartz, and to have originally formed isolated, nodular, or concretionary masses, which have been left behind in the decomposition and degradation of the strata in which they are embedded. They were not observed at any other locality.

The boulders are full of fossils, the assemblage being peculiar and quite different from that at Bomjardim. A large *Streptorhynchus* is especially abundant, and certain Lamellibranchs appear to be quite confined to this rock. Among these are species of *Pinna*, *Allorisma*, *Edmondia*, *Macrodon*, *Aviculopecten*, etc. Of these Mr. Derby has made a preliminary examination, and he will presently prepare a detailed report upon them. Several Gasteropods belonging to the

genera *Pleurotomaria*, *Euomphalus*, *Bellerophon*, also occur in these boulders.

About a mile and a half below Itaitúba Mr. Derby found a small exposure of a dark blue limestone, containing silicified shells, and, in a hand specimen brought away by him, *Athyris sublamellosa*, *Orthis Penniana*, Derby, sp. nov., and *Spirifera planoconvexa* are recognizable. This limestone lies horizontally.

At Cafezal, a few miles below Itaitúba and on the same side of the river, finely laminated, green shales crop out near low water mark. I found no fossils in them. Mr. Derby informs me that limestone occurs on the island in front of Cafezal.

Still further down the river is the little island of Pederneiras, on the upper end of which is a beach covered with chert nodules. On the right bank of the river, just opposite, is a point of the same name, on which are limestone and cherts, and just below, on the left bank of the river, is the locality, Castanha, at which limestone occurs. Mr. Derby reports that the exposure is on the river bank, a little above the mouth of the Igarapé de Castanha, extending along the river for some distance. The lowest bed is a very hard, light gray limestone containing scattered fragments of crinoids and other fossils, not silicified, together, apparently, with considerable ferric sulphide in small crystals, which last would unfit the rock for the purpose of making into lime. This bed is exposed only at low water and then only for a few feet. This is immediately overlaid by a finely laminated, soft, bluish or greenish shale, without fossils, over which lies a bed of a very light brownish, fine grained sandstone, more or less calcareous, of which only a thickness of a few feet was seen.

One of the most important exposures of the Carboniferous rocks is in a quarry on the right bank of the river, a short distance above the village of Urucuritúba. This quarry is known as the Pedreira de Vapor, "Vapor" being the nickname of a Sr. Silva, of Santarem, who quarries the stone to burn in a large kiln just above Santarem. The locality was visited by Mr. Derby, who made a section, and brought away specimens

of the different rocks. The quarry is a natural cliff about 60 feet in height, situated directly on the river.

Commencing at dead low water mark the section is as follows:—

- a.* Very pure, fine grained, light gray, splintery limestone, containing a few fossils similar to those of the Itaitúba limestone. This extends to a height of about 10 feet. The upper part is quarried for lime and shipped in large boats to Santarem.
- b.* Very light, yellowish gray, impure limestone, containing very fine sand. Thickness 3 feet.
- c.* Calcareous shale with thin black lamina. 6 inches.
- d.* Pure, compact, blue, splintery limestone. 1 foot.
- e.* Fine grained, light brown, impure limestone. 4 feet.
- f.* Very fine grained, light brown, calcareous sandstone. 10 inches.
- g.* Impure brown limestone (specimen probably decomposed). 6 feet.
- h.* Very fine grained, pure, white, silicious sandstone, soft and easily crumbled between the fingers.

The Cuparí is a small river, which, descending obliquely from the southward, empties into the Tapajos on the right bank, a short distance above Aveiros. Bates, who ascended it for some distance, reports rocky ledges and cascades, but he gives no definite information concerning its geology. While at Santarem in '70. I obtained from a Dr. Jones, a few specimens of rocks from that river, one of these being a heavy, splintery, rather dark gray limestone, precisely like one of the varieties at Itaitúba, and probably Carboniferous.

North of Aveiros, Carboniferous rocks have not yet been reported from the Tapajos.

I have given in detail the observations on the Carboniferous of the Tapajos. Unfortunately no continuous section of any thickness has offered itself, and in the present state of our knowledge, it is impossible satisfactorily to coördinate the beds. My own impression is that the sandstone just below the rapids will be found to be the lowest of the series, the shales

of Barreirinha coming next above, with the limestone and associated beds above these again. I much regret that the state of my health while at Itaitúba prevented my going more thoroughly over the whole ground, but I must leave this work to future explorers.*

The limestones of the Itaitúba series appear almost directly west of Itaitúba, on the Amána and Parauarí rivers, branches of the Maué-assú, where they were found by Mr. Chandless.

The following account is by Mr. Chandless:—†

“On the Parauary, a few miles below the first or lowest rapid, is on the right bank a cave, where the water has undermined the rock some 10 or 12 feet for a distance of 35 yards. The dark line of this, looking from a distance like the hull of a large canoe beside the bank, probably suggested its name—‘Pedra do Barco.’ A man I met below told me that he had been in the canoe at low water, and that there were flowers of stone on the roof, which I imagined would be gypsum flowers like those of the Mammoth Cave; but on arriving I found them to be fossil shells, sometimes suspended by a mere thread of stone. A good collection might be made in low water time; but now the water rises very near the roof, and it was with difficulty that I could get a few thence, and some in much worse condition from the edge. The strata are not far from horizontal but seem to incline a little eastward. The lowest bed, that forming the roof of the cave, is of a grey limestone, probably impure, but effervescing freely with lemon juice, and about one and one half feet thick. Above this is a similar bed divided from it by a shaly layer of 2 or 3 inches thick; above is a pink rock, apparently quite different. From the two chief beds project here and there what look like fossil roots *in situ*.

“On the left bank of the river Amana, just below the house ‘Frechal,’ and a few miles below the fall, I found the same

* I would suggest that geological work on the Tapajos should be done late in the dry season when the river is at its lowest, as when the water is high the more interesting localities are submerged.

† Notice of the Rivers Maué-assú, Abacaxis and Canumá. Journal Roy. Geogr. Soc., Lond. 1870. Vol. 40.

rock, easily recognized by the thickness of the beds, including the shales and the 'roots,' but with no cave, consequently the fossil shells were in much worse preservation. The beds were at about the same level with respect to the surface of the water in the two rivers, and therefore must certainly be at a much lower absolute level on the Amana. Among the fossils was, I think, a *Spirifer*. One could hardly mistake this; and one fossil, which I have compared at the Jermyn Street Museum, seems to me a *Productus*. It may be well to add that Dr. Coutinho found (as Professor Agassiz told me) Silurian fossils at one of the lower rapids of the Tapajos, in about lat. $4^{\circ} 32' \text{ s.}$ " *

Mr. Chandless has had the kindness to send me a specimen of *Productus* from the Pedra do Barco. It is identical with one of the commonest and most characteristic forms at Itaituba and as it is undescribed it has been dedicated to its discoverer, and *Productus Chandlessii*, sp. nov., will be found described and figured in the paper of Mr. Derby. No doubt therefore remains concerning the extension of the Carboniferous beds at least as far eastward as the Parauari.

While at Obydos, Sr. Gabriel gave Mr. Derby a decomposed chert nodule, which he obtained on the Rio Trombetas below the rapids. The specimen on being broken up has afforded a number of distinguishable fossils, like those occurring in the cherty rocks at Itaituba. Among them is a *Productus*, allied to *Productus Cora*, and a little species of *Posidonomya*, very common in the limestone at Bomjardim, and which in itself is sufficient to enable one to identify the Carboniferous rocks of the Coal Measures series on the Trombetas, on the opposite or northern side of the Amazonian valley.

Sr. Gabriel gave Mr. Derby a specimen of a fine grained, bluish, subsaccharine limestone much resembling some of the varieties found on the Tapajos, and which he reported to have been found just below the cachoeiras of the Trombetas.†

* This is the latitude of the cachoeira of the Apuim. Dr. Coutinho's fossils were, I believe, obtained from Itaituba.

† I may state here that Sr. Gabriel gave my assistant a fragment of sandstone exactly like that of the Devonian of Eréré, which he said he had obtained from one of the cachoeiras of the Trombetas.

As the Brachiopoda are the only fossils from the Tapajos that have been worked up, it is impossible, at present, to give more than a very rough sketch of the remaining part of the fauna.

Radiates are not numerous in the Coal Measures of the Tapajos. Corals are very rare, and but few have been collected, the most interesting being a little Cyathophylloid form, probably new. Fragments of the stems of Crinoids are quite common, and indicate that some of the species were of considerable size, but only one or two incomplete calyces have been found. The Echinoids are represented by at least one species of *Archæocidaris*.

Several species of Polyzoa are abundant at Bomjardim and Itaitúba. Thirty species of Brachiopoda have been identified from the Itaitúban rocks and twenty-seven determinable forms will be figured and described by Mr. Derby in the second number of this Bulletin, to which the reader is referred for an exhaustive discussion of this part of the fauna.

The Brachiopods of the lower Tapajos, taken as a whole, indicate an horizon equivalent to the Coal Measures, and the Itaitúban series has therefore been referred to that division of the Carboniferous. Aside from a few Ostracoids, the only Crustacean detected is a pretty little *Phillipsia*, occurring in the limestone at Bomjardim, and in the decomposed cherts and the silicious boulders at Itaitúba. Lamellibranchs are very abundant, especially in the silicious boulders, and are noted for their large size. The material to illustrate this group is mainly in the shape of casts, and will be difficult to work up. It seems hardly worth while to give here the incomplete results so far arrived at. Gasteropods are quite numerous, embracing species of *Pleurotomaria*, *Euomphalus*, *Bellerophon*, *Macrochæilus*, *Murchisonia*, etc. I have been struck with the almost entire absence of Cephalopods from the Coal Measures of the Tapajos, for I have seen but a single incomplete specimen of *Orthoceras*. Vertebrate remains appear to be very rare in the rocks at Itaitúba, but I have a few Ganoid scales from the limestone at Paredão, together

with numerous teeth, spines, etc., from the septaria of Barreirinha and vicinity.

Mr. Derby has shown that the Brachiopods of the Bolivian Carboniferous fauna indicate the same horizon as the Itaitúban. Prof. Orton has kindly sent me a few fossils found near the foot of the Andes, on the Pichis river, an affluent of the Pachitea. Mr. Derby has dissolved up a limestone pebble in the collection and has obtained from it good silicified specimens of *Eumetria Mormonii* (*punctulifera*), *Spirifera planoconvexa*, and *Spirifera camerata*, indicating that the same beds of the Coal Measures occur also at the foot of the Andes, at the locality just mentioned. We have now the evidence of the existence of marine deposits of the Coal Measures underlying the great, western, interior Amazonian basin, and that they appear on both sides of the valley. It is probable that, at the time of the Coal Measures, the Amazonian basin was an open sea. The rocks of the Itaitúban series appear to have been formed near the shore, in shallow water.

The very important question arises as to whether coal exists on the Amazonas. It is impossible, in the present state of our knowledge, to make a prediction, but it would, however, be strange if, in a Carboniferous basin of such immense extent, coal beds should not occur, and it seems plainly the duty of the Brazilian Government to institute a careful Geological Survey of the valley, with the view of ascertaining the exact character and extent of the Carboniferous beds, but, at present, I should not feel authorized in encouraging individual effort in that direction.

To return to Itaitúba. The land on the eastern side of the river opposite the village rises abruptly, forming an elevated, flat topped chapada, 300 feet in height, more or less. This is undoubtedly underlaid by Carboniferous rocks, but the upper part is probably an extension of the horizontal, soft, clayey rocks of the Tertiary (?) series, better seen lower down the river. These high lands are heavily wooded and I know of no exposures of the strata. Above Uixitúba the shore is strewn with rocks, but there were no good exposures at the

time of my visit, and I could make out nothing. At Uixitúba the shore is strewn with Carboniferous cherts.

From Aveiros to Alter do Chão* the eastern side of the river continues high and presents a steep slope to the river, while the opposite side is, for the greater part, very low.

Five or six miles below Aveiros, on the right side of the river, commences a line of cliffs which extends northward for several miles. These Mr. Derby found to be composed of a light, whitish red, tabatinga clay, streaked like Castile soap with irregular lines of a redder tint. The bed is very homogeneous and without lamination, and the cliffs, which are very picturesque, are often 60 to 70 feet high.

Opposite Aveiros the left bank of the river is high, but I have not had an opportunity of examining it. At Aveiros specimens of trap, said to have come from that quarter, were given me. Similar specimens were also given to Mr. Derby, together with a few fragments of baric sulphate. South of Aveiros the left bank of the river is low. Between Itaitúba and Aveiros there extends along the western side of the river a line of low, alluvial islands; but below Aveiros islands are few, and the river widens rapidly toward Villa Franca, presenting an open, sea-like expanse. The shores are fringed, like the sea, by beautiful sandy beaches. Indeed, in hazy weather, one walking along the shore, when the opposite, low, western bank is not visible, forgets that he is not by the sea-side.

From Aveiros to Alter do Chão the river banks are remarkably straight, and there are no important points or indentations; but, at Alter do Chão, the eastern shore curves abruptly westward, making a deep, beautiful bay. It then, at the Ponta do Cururú,† bends sharply northward, and, between this point and Santarem, forms a series of shallow coves fringed by sand beaches. This coast, which is often abrupt, I went over on foot in 1870, examining the strata in each cliff. In my Final Report I will give all the results of this examination in

* Properly, Alter do Chão.

† *Kururú*, Língua Geral, means toad. At the point is a large rock resembling this animal.

detail, but in this paper I must limit myself to a general account of this interesting region.

On reaching Alter do Chão, the highlands, instead of bending westward with the coast, continue on towards the north to a point a few miles to the north-east of Santarem, or the mouth of the Tapajos, where they bend off abruptly towards the eastward, and skirt the alluvial plains of the Amazonas on the south side of the valley, for a long distance. From over the tract between Alter do Chão, the Ponta do Cururú, Santarem and the highlands, the Tertiary (?) beds have been more or less denuded, and the material worked over. In the immediate vicinity of the village of Alter do Chão are several outlying hills with precipitous faces showing the stratification, but I was unable to visit them.

The Serra Piróca, or Alter do Chão, is an isolated, very abrupt, narrow, and very short, wedge-shaped ridge, that rises right out of the plain, at a little distance from the bay, its height being 200 feet, more or less, but, as I made no measurement, its bareness and isolation may have led me to exaggerate its height. It forms a very prominent object and is visible for a long distance. From the south it appears like a very sharp pyramid, but from the west it presents a truncated appearance. The ridge is only about 600 feet long. Its sides are very steep, destitute of trees, and difficult to climb. The upper part is quite bare, whence the name *piróca*.^{*} The upper part of the hill is composed of a heavy bed of white tabatinga clay, baked very hard. In this clay are great numbers of the nests of a species of trap-door spider. Scattered about over the surface are fragments of red clay ironstone, and embedded in the clay are large masses of the same material. Under the tabatinga clay comes a heavy bed of a soft, fine grained, argillaceous sandstone, mottled with red and yellow, and with occasional yellow bands, while the base of the hill seems to be composed of a yellowish, sandy clay. On the western side, near the base, is a mass of soft sandstone with a tabatinga cement and obliquely laminated, but I could not determine whether it be-

^{*}Tupí, *bald*.

longed to the same formation, or whether it was more recent. Around the base of the mountain are a number of little hills, apparently of a newer formation. Their surface is covered with fragments of sandstone. The Serra Piróca commands a magnificent view. Between this hill and the Amazonas there are other outliers of the same formation. Just west of Santarem, at a distance of five miles, more or less, is the isolated conical hill of Irurá, 200 or 300 feet high, and the lower and broader topped hill of Panéma, the latter showing on top a stratum of hard, sandy clay. None of these outliers, however, show very clear sections. Not a trace of fossil remains has as yet been found in these beds, so that their exact age cannot be determined, but they are certainly not older than the Tertiary. Much of the country, from over which these beds have been denuded, is exactly like the similar regions in the vicinity of Monte Alegre, and just east of Santarem lie broad, gently rounded, swelling campos, precisely like the ridge north of Monte Alegre, and doubtless a degraded and rearranged outlier of the highlands. This sandy campos land is of course unfit for cultivation. The foot of the highlands and the level country above are well forested and furnished with a good soil. At intervals along the tops of the bluffs are the sites of ancient Indian villages, where the soil, often over many acres, is a light, rich, black loam, through which, to a depth of several feet, fragments of pottery, stone implements, etc., are found. These sites of the Bluff-dwellers are not confined to the highlands immediately above Santarem, but extend along the edge of the valley as far, at least, as Taperinha. Contrary to what might have been at first expected, the lands on the bluffs are not only fertile, but they retain moisture through the long dry season. Several American and two English families have established themselves along the bluffs and have succeeded excellently in agriculture. Their principal crop is sugar-cane, which grows extraordinarily well on the highlands; indeed I do not know that I ever saw any where better cane than that on the plantation of Sr. Rhome at Taperinha. Excellent tobacco is also raised, together with corn,

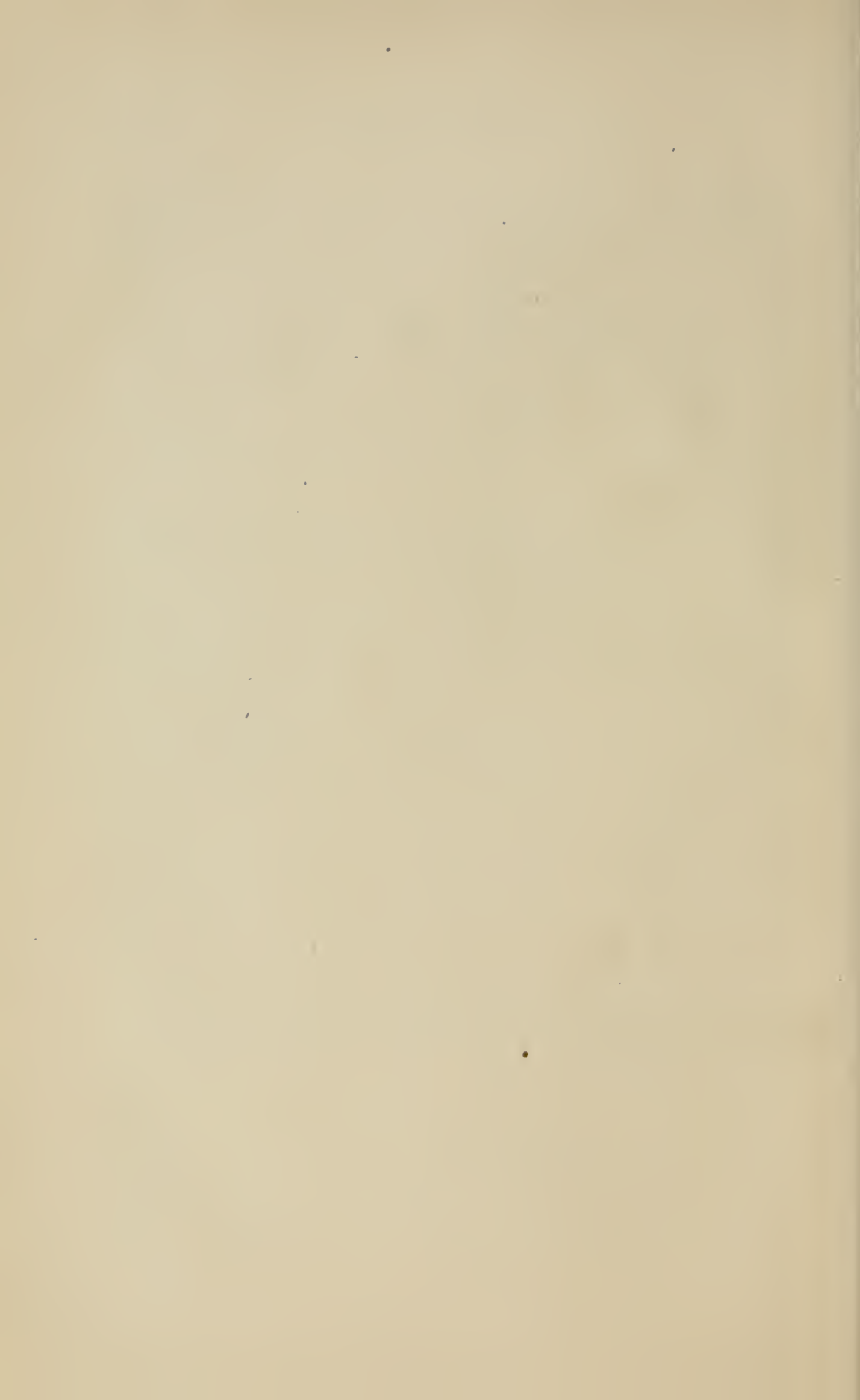
mandioca, cotton, rice, etc. The climate of the vicinity of Santarem is very agreeable and healthy, and I was assured by the planters, most of whom came from the Southern States, that the heat was not more oppressive than in Louisiana. After having personally examined several of these plantations, and having taken pains to collect reliable information concerning them, I am satisfied that, almost under the Equator, and in a thoroughly tropical climate, the Anglo-Saxon laborer can successfully compete with the native, and I can see nothing but prosperity in store for the American settlers in the vicinity of Santarem.*

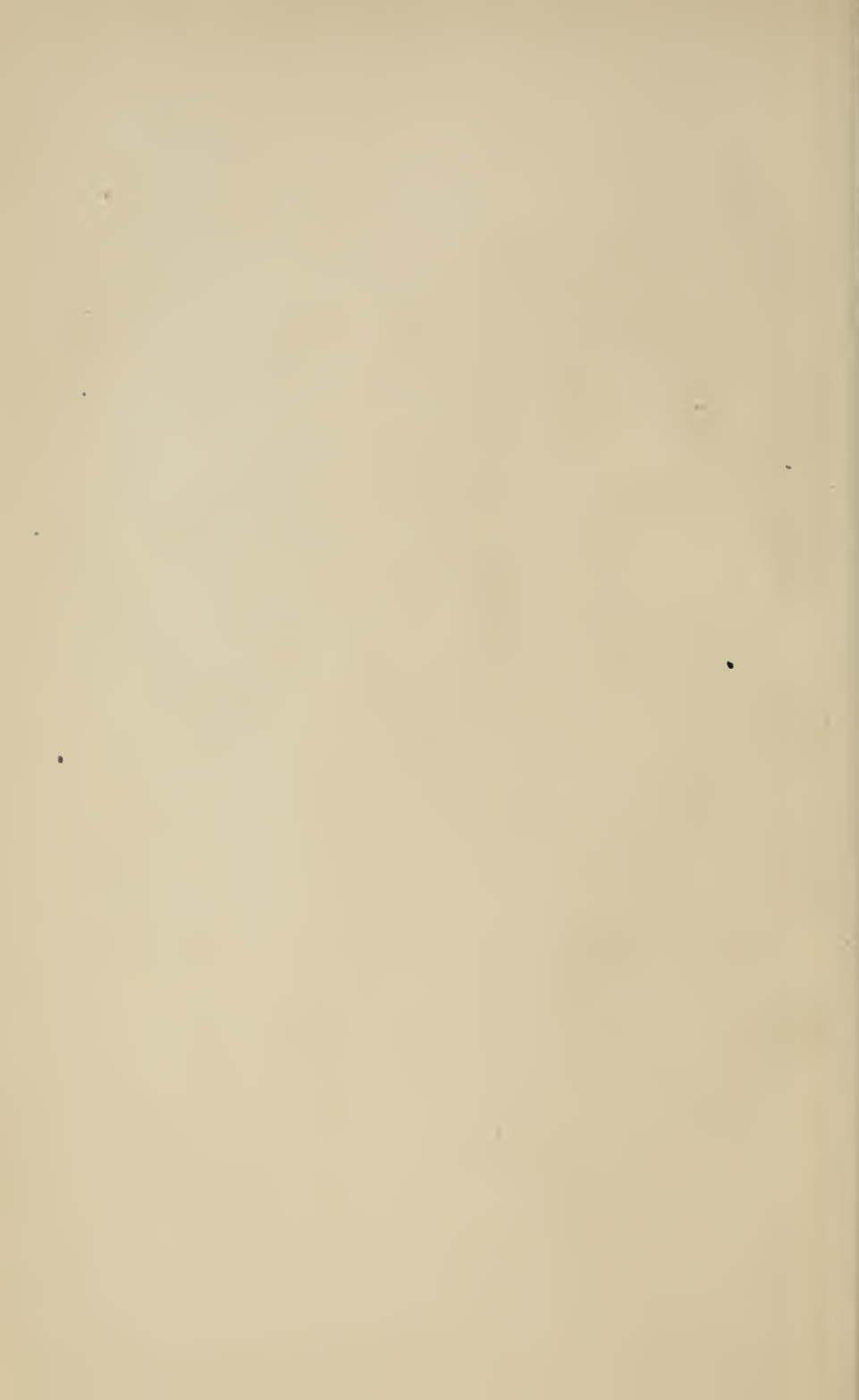
At Villa Franca the Tapajos is about 8 miles wide, and forms a deep bay on the northern side. Between this and the main river, there projects southward a tract of very low, alluvial land, which gradually narrows down the river, until, at Santarem, it is not a mile in width. This tract has been formed by the silting up of the channel of the Amazonas, and by the fusion of islands.

The Tapajos at its mouth is deep, and navigable for large steamers, but, during the dry season, the river, from near Santarem to Itaituba, is very shallow and navigable only for boats drawing but little water.

The important little city of Santarem is situated on high ground on the eastern side of the river, near its mouth, and, blessed with a good, healthy climate and a clean location, it promises one day to be one of the most important ports of the Amazonas.

* I regret to be obliged to do such scant justice to this very important agricultural region, but I shall take care to describe it carefully in my Report, in which, besides the observations of Mr. Derby and myself, I shall be able to give the results of a recent examination by Mr. Herbert Smith.





No. 2.

MORGAN EXPEDITIONS, 1870-71.

CH. FRED. HARTT, *in charge.*

On the Carboniferous Brachiopoda of Itaituba, Rio Tapajos, Prov. of Pará, Brazil. BY O. A. DERBY, B. S.,
Instructor in Geology and Palæontology in The Cornell University.

Genus TEREBRATULA, Llhwyd.

TEREBRATULA ITAITUBENSIS, sp. nov. Pl. II, Figs. 1, 3, 8, 16; Pl. III, Fig. 24; and Pl. VI, Fig. 15.

Shell large, elongate, varying from subelliptical to broadly ovate, the greatest width being anterior to the middle; valves moderately, to strongly convex; lateral margins more or less arched ventrally, giving to the whole ventral valve a flexed appearance; anterior margin strongly rounded, and uniting with the lateral margins by a regular curve.

Ventral valve ovate or oval in outline, more or less strongly convex posterior to the middle, the convexity decreasing gradually toward the front, where the valve is usually flat; beak prominent, more or less broadly flattened, and abruptly incurved, extending considerably beyond the hinge line, and truncated by a large, circular foramen, which is separated from the hinge by a deltidium of moderate size; sides of beak flattened, forming, on each side, a rather broad, sometimes strongly concave, falciform area, that extends forward nearly to the middle of the valve, and is separated from the middle portion of the beak by a more or less distinct, and sometimes overhanging ridge.

Dorsal valve subelliptical, the posterior lateral margins strongly divergent, and often concave; longitudinal curvature usually very slight, and much less than the transverse, the latter being regular or increasing towards the median line; beak small, moderately prominent, apex obtusely pointed.

Surface smooth, marked with numerous faint lines of growth. Structure minutely punctate.

In the interior of the ventral valve the dental plates are

strongly developed, and but slightly divergent, extending from the teeth backward to the apex of the rostral cavity, and downward and slightly forward to be attached along the bottom of the valve.

In the interior of the dorsal valve the inner wall of the socket is formed, on each side, by a small ridge just within the margin; a little anterior to this and diverging slightly from it is another ridge, undoubtedly for the support of a loop; between the crural ridges and extending somewhat in front of them at the middle, is a lozenge-shaped plate, but slightly raised above the bottom of the valve, with which it is apparently connected along the median line. A cast of the upper surface of this plate shows sculpture, probably produced by the attachment of muscles.

Three specimens measure as follows:—

Length 32 mm.; width 23 mm.; thickness 14 mm.

“ 36 “ “ 26 “

“ 32 “ “ 32 “

The last is an unusually short and broad ventral valve. There are several dorsal valves equal to it in width, but their length is greater.

This species, in its interior details, resembles very closely *T. elongata*, Schloth., illustrated in Pl. I, Figs. 18 and 20, of Davidson's Monograph of British Permian Brachiopoda, but it may be readily distinguished from that species, and from the European Carboniferous *T. hastata*, Sow., by the absence of fold and sinus. The same negative character separates it from *T. bovidens*, Morton, from which it also differs in many other respects. This last species is moreover, according to Dr. White, a *Waldheimia*.

Our species is perhaps more nearly allied to *T. inornata*, McChesney, (Description of New Palæozoic Fossils, 1859); but that form does not appear to be sufficiently well known to admit of our making a satisfactory comparison.

The specimen represented in Fig. 24, Pl. III, is thought by Mr. Whitfield to be the young of *T. itaitubensis*. If not, it is an undetermined species, since it cannot be referred to

Waldheimia Coutinhoana, nob., the only other Terebratuloid form yet known from the locality.

POSITION AND LOCALITY.—Coal Measures, most abundant in the large, silicious boulders on the beach at Itaitúba. A few specimens have also been found in the limestone at Bomjardim.

Genus WALDHEIMIA, King.

WALDHEIMIA COUTINHOANA, sp. nov. Pl. III, Fig. 22; Pl. VIII, Fig. 6; and Pl. IX, Figs. 1, 2.

Shell of moderate size, varying from moderately convex to ventricose; ovate or subelliptical, greatest width at, or near the middle, and always somewhat less than the length. Ventral valve rather more convex than the dorsal, and longitudinally arcuate; beak small, strongly recurved beyond the hinge line, the extremity pierced by a round foramen of moderate size, separated from the hinge margin by a deltidium consisting of two elongated, triangular pieces; sides of the beak carinate, a sharp, angular ridge extending, on each side, nearly to the middle of the valve and bordering a narrow, concave, falciform space. Dorsal valve ovate, quite regularly convex.

Surface smooth, with a few, usually indistinct lines of growth, sometimes quite prominent at the margin in the larger specimens; structure closely punctate.

In the interior of the ventral valve the dental plates are strongly developed and subparallel, extending along the bottom of the valve from the beak to a point opposite to, or somewhat in advance of the teeth.

In the dorsal valve, the space between the sockets and the beak is bridged over by a shelly plate, from the interior margin of which rises a long, slender loop, each branch of which, near its origin, bears on its ventral side a small triangular spur. The branches of the loop, diverging at first and very slender, curve gradually inwards, until, near the front of the valve, they are more or less inclined towards one another. ' With a sharp curve, they are then abruptly bent backward, widening

rapidly at the same time into broad, thin laminae, which curve more strongly outward than the dorsal branches. In going backwards the laminae gradually widen nearly to the front of the hinge plate, where their extremities are joined by a slender transverse band. The anterior extremities of the loop are furnished with a few, small, lamellose spines. A very short, slight mesial septum extends forward from beneath the hinge plate, but does not appear to unite with it.

Two specimens measure as follows:—

Length 14 mm.; width 12 mm.; thickness 7 mm.

“ 18 “ “ 16 “ “ 4 “

The last measurement is of an unusually flat specimen.

This species, in the form of its loop and in its other interior characters, agrees so closely with the typical *Waldheimias* that there can be no doubt about its generic relations. The only important difference it presents is that the dorsal mesial septum does not unite with and support the hinge plate, while, in the ventral valve, the teeth are supported by prominent dental plates like those, not only of the *Terebratula* with which it is associated, but of Carboniferous *Terebratulas* generally, so far as their interiors are known.

Specimens showing only the exteriors may be distinguished from *T. itaitubensis* by their smaller size, and the narrower and more elongated beak, the ridges of which are more prominent and angular than in the species just named.

Dedicated to Dr. Silva de Coutinho, the companion of Prof. Agassiz in his exploration of the Amazonas.

POSITION AND LOCALITY.—Coal Measures; in the limestone at Bomjardim; also in a white, chalky, decomposed chert found in small fragments on the beach at Itaitúba; very rare in the large, silicious boulders at the same place.

Genus EUMETRIA, Hall.

EUMETRIA PUNCTULIFERA, Shumard, sp. Pl. VIII, Figs. 4, 5, 7, 8, 10; Pl. IX, Fig. 3.

Retzia punctulifera, Shumard, 1858, Trans. St. Louis Acad. Sci., Vol. I, p. 220: Meek, 1872, Final Report of Geol. of Neb., p. 181, Pl. I, Fig. 13; and Pl. V, Fig. 8.

Terebratulæ Mormonii, Marcou, 1858, Geol. of N. Am., p. 51, Pl. VI, Fig. 11.

Retzia Mormonii, Meek and Hayden, 1859, Proceed. Acad. Nat. Sci. Phila., p.

27: Geinitz, 1866, Carb. und Dyas in Neb., p. 39, Tab. 3, Fig. 6.

Retzia subglobosa, McChesney, 1859, Desc. of New Pal. Fossils, p. 45.

Shell small, gibbous, longitudinally ovate, ventral valve more convex than the dorsal; hinge line straight, uniting with the lateral margins at an obtuse angle, its length being usually considerably less than half the greatest width.

Ventral valve most elevated at, or posterior to the middle, the convexity growing less towards the front; beak prominent, large, subconical, strongly incurved, passing slightly beyond the hinge line, truncated by a large, circular foramen, below which is a well developed, more or less concave area, defined by angular cardinal margins; area triangular, with the apex truncated by the foramen, middle marked by a slight, depressed line or furrow extending from the foramen to the hinge. Dorsal valve with greatest convexity in the umbonal region; beak short, not prominent, strongly incurved, the apex being pointed and passing slightly beyond the hinge line; valve flattened on each side of the beak, forming a small ear extending to the cardinal angles.

Surface of both valves marked by about seventeen simple, very prominent, rounded plications, separated by reverse plications of equal width, and corresponding in form; near the margins are a few indistinct lines of growth. Shell structure minutely punctate.

In the interior of the ventral valve the teeth are small, unsupported by dental plates, and situated near the extremity of the hinge line; no septum has been observed, and the muscular marks are indistinct.

In the dorsal valve, the cardinal process forms a broad, transverse, curved plate, convex towards the front of the valve, and bent back past the hinge line into the beak of the ventral valve; anteriorly its margins are united with small socket plates, projecting straight forward and supporting the spires from their margins. From the middle of the lower part of the anterior face of the plate forming the cardinal

process, a slender, hooked process projects forward and upward, the inferior face of this process bearing a small, thread-like ridge, which is continued along the bottom of the valve as a mesial septum, and on each side of which is an elongated, oval, muscular scar. Each spire consists of six (?) coils, the first of which has a small, triangular spur near the origin, at the point where the two spires most nearly approach each other; outer margin of coils pectinated.

Two specimens measure as follows:—

Length 10 mm.; width 7 mm.; thickness 6 mm.

“ 13 “ “ 11 “

None of the specimens of this species from Itaitúba show any trace of the large deltidium figured by Mr. Meek in Fig. 13, Pl. I, of the Final Report of the Survey of Nebraska, though a number of them have the area perfectly exposed. The depressed line in the centre of the area is quite a different thing, as will be seen by a comparison of figures. Specimens from the typical locality in Kansas agree exactly with the Brazilian specimens. If the appearance of a deltidium is not deceptive, there are probably two distinct species confounded under the name of *E. punctulifera*, since the presence or absence of this character ought certainly to be of specific importance.

Prof. Hall refers this species to his genus *Eumetria*, proposed in 1863 (16th Annual Rept. of State Cabinet of Nat. Hist.) as a division of *Retzia*.

POSITION AND LOCALITY.—This species occurs in the Coal Measures limestone of Bomjardim and in the loose fragments on the beach at Itaitúba. I have also recognized it in a limestone pebble from Peru, sent me by Prof. Orton. The specimen was collected by him from the bed of the Pichis river, a branch of the Pachitea, a western affluent of the Ucayali. This is a new locality for the Carboniferous in South America, situated about six degrees north-west of Lake Titicaca, where d'Orbigny obtained Carboniferous fossils. The rock on the Pichis was not seen *in situ*, but, judging from the specimen, it must be rich in fossils. Associated with this spe-

cies were *Spirifera camerata*, Morton, *S. planoconvexa* (?), Shumard, *S. perplexa*, McChes., (*S. lineatus*, aucts.), a species of Rhynchonella or Camarophoria, and a Terebratula resembling *T. bovidens*, Morton. The last is perhaps identical with a form from Cochabamba, described by Toula under the name of *T. Hochstetteri*.

Genus ATHYRIS, McCoy.

ATHYRIS SUBTILITA, Hall, sp. Pl. I, Figs. 5, 7, 8; Pl. III, Figs. 8, 16, 19; Pl. VI, Fig. 2; and Pl. IX, Fig. 4.

Spirifer Roissy,* d'Orbigny, 1842, Pal. du Voy. dans l'Am. Merid., p. 46, Pl. III, Figs. 17, 18 and 19.

Terebratula subtilita, Hall, 1852, Stansbury's Great Salt Lake Report, p. 409, Pl. IV, (by error in text II) Figs. 1 and 2: 1856, Pacific R. R. Reports, Vol. III, p. 101, Pl. II, Fig. 3, 4, 5: and 1858, Geol. of Iowa, Vol. I, Part 2, p. 714: Schiel, 1855, Pacific R. R. Report, Vol. II, p. 108, Pl. I, Fig. 2.

Terebratula? subtilita, Davidson, 1857, Mon. Brit. Carb. Brach., p. 18, Pl. I, Figs. 21, 22.

Spirigera subtilita, Meek and Hayden, 1859, Proc. Acad. Nat. Sci. Phil., p. 20.

Spirigera (Athyris) subtilita, Toula, 1869, Über einige Fossilien des Kohlenkalkes von Bolivia, p. 6, Tab. I, Fig. 5: aus d. LIX, Bde. d. Sitzb. d. Kais. Akad. d. Wissensch., I Abth. März-Heft.

Athyris subtilita, Davidson, 1860, Mon. Brit. Carb. Brach., p. 86, Pl. XVII, Figs. 8-10: and 1865, Carb. Brach. of India, Quart. Jour. Geol. Soc., Vol. 18, p. 28, Pl. I, Figs. 7 and 8: 1863, Nova Scotian Brach., Quart. Jour. Geol. Soc., Vol. 19, p. 170, Pl. IX, Figs. 4 and 5, and Acadian Geology, p. 290: and 1866, Carb. Brach., from Valley of Kashmere, Quart. Jour. Geol. Soc., Vol. 22, p. 40, Pl. II, Fig. 2: Salter, 1861, Bolivian Fossils, Quart. Jour. Geol. Soc., Vol. 17, Pl. IV, Fig. 4: Newberry, 1861, Ives' Colorado Report, p. 126: Meek, 1872, Final Report of Geol. Sur. of Neb., p. 180, Pl. I, Fig. 12; Pl. V, Fig. 9; Pl. VIII, Fig. 4: Meek and Worthen, 1873, Geol. Sur. of Ill., Vol. V, p. 570, Pl. 25, Fig. 14.

Shell ovoid or subrhomboidal, somewhat longer than wide, greatest width at, or a little anterior to the middle, strongly convex or gibbous.

Ventral valve more convex than dorsal, with greatest convexity between the beak and middle; mesial sinus rounded, shallow and narrow in young specimens, becoming broader and

* *Terebratula peruviana*, on plate by error. A Devonian shell is described and figured as *T. peruviana*, p. 36, Pl. II, Figs. 22-25. Curiously enough the author in attempting to correct this error commits another, applying still a third name (*T. antisienensis*,) to the figures of *Athyris subtilita*.

deeper towards the front of the larger specimens in which it is almost always much prolonged in a broad, linguliform expansion indenting deeply the margin of the dorsal valve; beak prominent, rounded, strongly incurved over that of the dorsal valve, truncated by a large, circular foramen, incomplete in front, below which is a large, triangular fissure filled by the beak of the dorsal valve, and entirely concealed when the valves are united.

Dorsal valve usually but little curved from beak to front along the middle, which forms a rounded ridge from which the sides slope with but slight curvature to the margins; front often elevated in a distinct, rounded fold, extending more or less toward the middle; beak broadly rounded, distinctly incurved into the fissure under the ventral beak.

Surface smooth, with numerous lines of growth, which often become very prominent, lamellose, and close, near the margins of adult specimens.

In the interior of the ventral valve, a strong, curved tooth is situated on each side of the base of the fissure, supported by dental plates that extend to the bottom of the valve a little in advance of the teeth.

Just in advance of the dental plates are the narrow, elongated muscular impressions. The united oclusors are elongated, and cordate in outline. Those of the divaricators originate as far back as the oclusors. Posteriorly they are very narrow but they widen rapidly towards the front, becoming conjoined in advance of the oclusors, and extending somewhat beyond the middle of the valve, their united outline in front being cordate.

In the dorsal valve the inner socket walls are formed by two strong, vertical plates that extend backward, passing the beak in a tooth-like projection on each side.

The socket plates are connected near their middle by a transverse crural plate, rising vertically, or slightly inclined forward, and extending somewhat above the margins of the socket plates. The lateral margins of this plate are prolonged as slender crura supporting the arms. Muscular impres-

sions in two pairs, (quadruple impressions of occlusors of Davidson), the upper pair narrow, elongated, beginning in front of the cardinal process, and separated by a broad, more or less elevated ridge; those of the other pair narrow, elongated, ovate, originating between the anterior extremities of the former scars, Posteriorly these last are separated by the point of the mesial septum, but they become conjoined and widen considerably as they extend forward to beyond the middle of the valve.

Arm supports forming two obtuse cones, consisting each of fourteen or more coils, the two spires being connected by a complicated accessory loop. Lamellæ of coils pectinated on their outer margin. Originating from the crural plate, the lamellæ of the arm supports at first extend for some distance obliquely forward and towards the ventral valve. They then bend very abruptly and extend obliquely backward and outward, behind the point of origin, forming in this way two primary flextures which are not only directed obliquely forwards, but are inclined slightly towards one another. Following the curvature of the dorsal valve, the more or less wide, vertical lamellæ curve forward parallel with one another, narrowing down towards the front of the valve, near which they bend ventrally to form the spires. The dorsal portion of the first coil sometimes forms a very wide lamella resembling in outline the blade of a skate. Nearly opposite the middle of the valve the ventral edge of this lamella, on each side, gives rise to a slender process which extends obliquely forward nearly to the centre of the cavity of the shell, when the two processes, widening rather abruptly, are united in a more or less broad, saddle shaped arch, emarginate in front and prolonged backward, along the median line, in a slender thread, that bifurcates just over the primary flextures above described, forming two slender branches, each of which, following closely the outer side of the neighboring lamella, and corresponding with it in curvature, extends nearly to, or beyond (?) the origin of the accessory loop, ending apparently with a free extremity.

Three example measure as follows:—

Length 28 mm. ; width 24 mm. ; thickness 18 mm.

“ 28 “ “ 27 “ “ 16 “

“ 33 “ “ 29 “ “ 21 “

The majority of the Brazilian specimens of this species are remarkable for the lingulate expansion at the front of the ventral valve, which is much longer and narrower than is usual in specimens from other localities. All adult specimens from the limestone show this character, while those from the silicious boulders agree more nearly with the type of the species. The muscular impressions resemble closely those of *A. ambigua*, Sow. illustrated in Davidson's Mon. of Brit. Carb. Brach., Pl. XVII, Figs. 13 and 14. The accessory loop is also very like that of the same species, but the spires consist of more numerous and more closely arranged coils, forming a much more obtuse cone. The hinge plate is also quite different from that of the species just named, but it agrees with specimens of *A. subtilita* from Western North America, in Prof. Hall's collection, and with the figure in the fifth volume of the Illinois Reports.

POSITION AND LOCALITY.—Specimens of this species are abundant in the Coal Measures limestone at Bomjardim and on the beach at Itaitúba, but are rare in the silicious boulders. It has also been found in a drab-colored limestone from Paredão, a limestone cliff on the west bank of the Tapajos a few miles above Itaitúba.

ATHYRIS SUBLAMELLOSA, Hall, Pl. II, Figs. 9, 10, 11, 12 ; Pl. III, Figs. 15, 21, 29 ; Pl. VI, Fig. 16 ; and Pl. IX, Figs. 5, 6.

Athyris sublamellosa, Hall, 1858, Geol. Sur. of Iowa, Part 2, p. 702, Pl. XXVII, Fig 1.

Compare *Athyris pectinifera*, Sowerby.

Shell of moderate size, subelliptical or ovate, rarely longer than wide, greatest width near the middle ; more or less gibbous, often with a flattened expansion at the margins, valves about equally convex.

Ventral valve most convex in the umbonal region, more or less flattened at the margins, and, in large, globose specimens, furnished with a slight, broad depression in the middle of the front, slightly indenting the margin; beak moderately prominent; rather attenuated, more or less incurved, truncated by a round foramen of moderate size, the front of which is formed by the beak of the dorsal valve.

Dorsal valve strongly convex or gibbous in the umbonal region, depressed or flattened towards the margins, and usually without any elevation corresponding to the depression of the opposite valve.

Surface marked by close, concentric, imbricating lamellæ, the margins of which when perfect are extended in fine, flattened spines.

The interior of the ventral valves is much like that of *A. subtilita* in the general form and arrangement of the parts. The muscular impressions and the cavity between the hinge plates are, however, much shorter and broader.

In the dorsal valve, the united socket and crural plates form a narrow, nearly flat plate that extends, nearly in the plane of the margin, over the triangular space between the sockets and the beak, and is pierced just under the point of the beak by a small, circular foramen. The arm supports form on each side an acute cone, consisting of about nine coils. The accessory loop is very similar to that of *A. subtilita*, but it differs from it in that the anterior saddle-like plate is not situated so far forward as in *A. subtilita*, making the accessory loop shorter, and that at the origin of the arm supports in *A. sublamellosa*, the reflexed lamellæ pass downward in front of the attachment to the crura, while they pass back of the same point in *A. subtilita*.

Muscular area elongated, oval, extending considerably beyond the middle of the valve, the posterior pair of impressions being separated by a slender mesial septum.

Four examples measure as follows:—

Length 19 mm.; width 20 mm.; thickness 10 mm.

"	18	"	"	21	"	"	13	"
"	23	"	"	25	"	"	11	"
"	23	"	"	20	"	"	15	"

The last is an unusually narrow, gibbous form.

Prof. Hall identifies this shell from Itaituba with his species *A. sublamellosa*, which in North America occurs in the Chester Limestone. The Brazilian form is closely related by both external and internal characters, to the European Permian species *A. pectinifera*, Sow. The spire and accessory loop agree almost exactly with those of that species, and the hinge plate is perforated in a similar manner.

POSITION AND LOCALITY.—This species is found quite abundantly in the Coal Measures limestone at Bomjardim, and on the beach at Itaituba.

Genus SPIRIFERA, Sowerby.

SPIRIFERA CAMERATA, Morton. Pl. I, Figs. 1, 3, 6, 9, 14; Pl. II, Figs. 2 and 15; Pl. IV, Fig. 5; Pl. V, Fig. 11.

Spirifer cameratus, Morton, 1836, Am. Jour. Sci. Vol. XXIX, p. 150, Pl. II, Fig. 3; Hall, 1856, Pacific Railroad Report, Vol. III, p. 102, Pl. II, Figs. 9, 12 and 13; and 1858, Geol. Sur. of Iowa, Vol. I, Part 2, p. 709, Pl. XXVIII, Figs. 2 a and b.; Meek, 1872, Final Report of Geol. Sur. of Nebraska, p. 183, Pl. VI, Fig. 12; and Pl. VIII, Fig. 15.

S—— *Condor*, d'Orbigny, 1842, Pal. du Voy. dans l'Am. Mer., p. 46, Pl. V, Figs. 11-14.

S—— *Meusebachianus*, Roemer, 1852, Kreid., von Texas, p. 88, Pl. XI, Fig. 7.

S—— *triplicatus*, Hall, 1852, Stanbury's Report, Salt Lake Exp., p. 410, Pl. II, Fig. 5. (by error Pl. IV).

S—— *fasciger*? (v. Keyserling) Owen, 1852, Report Wisconsin, Iowa, and Minn., Pl. 5, Fig. 4.

S—— ——— H. D. Rogers, 1858, Geological Report Pennsylvania, Vol. II, p. 833, Fig. 694.

S—— *striatus*, var. *multicostatus*, Toula, 1869, Über einige Fossilien des Kohlenkalkes von Bolivia, p. 3, Pl. I, Figs. 2, 3 and 4, (aus d. LIX, Bde. d. Sitzb. d. Kais. Akad. d. Wissensch., I Abth. März-Heft.)

Shell large, variable in outline, transversely subelliptical or subtrigonal, more rarely subsemicircular, ventricose or gibbous; hinge line always equal to greatest width of shell, cardinal extremities varying from obtuse, to much extended and more or less acute.

Ventral valve more convex than dorsal; mesial sinus narrow, well defined, and subangular at the beak, becoming broader and deeper, but more rounded and less sharply separated from the sides towards the front; beak prominent, strongly and abruptly incurved, the apex being pointed and directed forwards; area moderately high, with subparallel margins, nearly flat, but curving strongly under the apex of the beak, surface marked by coarse, parallel, vertical striae, which sometimes give a crenulated appearance to the hinge line; fissure large, its height being equal to, or greater than the width, margins grooved.

Dorsal valve moderately to strongly convex, highest at the middle; fold narrow at the beak, becoming broad at the front, variable in its character, being strongly elevated or depressed, flattened or rounded, sharply defined or passing gradually into the sides of the valve; beak not very prominent, passing slightly beyond the hinge line, and incurving over the narrow area; fissure triangular, much broader than high.

Surface ornamented with moderately strong, bifurcating, radiating plications, of which from six to ten occupy the fold and sinus. The plications on the sides are often more or less distinctly grouped in fasciculi, consisting of from three to six ribs. Growth lines numerous, close, concentric, zigzag and more or less irregular, usually indistinct in the umbonal region, and becoming prominent and more or less lamellose towards the front.

The surface is also marked by minute granules, arranged in close, radiating lines, giving the plications a finely striate appearance.

In the interior of the ventral valve the dental plates extend to the bottom of the valve, and are usually considerably produced, partially enclosing the muscular area. Usually, through the thickening of the valve, the space between the dental plates and the area becomes filled up, and the cavity of the beak is often more or less completely filled in the same manner. The muscular area is usually deeply depressed,

varying in shape from a broad, lozenge-shaped figure, to an elongated oval. The occlusors form an elongated, narrow, double scar in the middle of this area, on each side of which are the broader, irregularly shaped impressions of the divaricators. Inner surface of the posterior portion of the valve strongly pitted in old, thickened specimens.

In the dorsal valve, the apex of the beak is occupied by a moderately large, transversely flattened cardinal process, coarsely striated on its anterior face, from the sides of which, along the margins of the fissure, but not attached to the bottom of the valve, extend the socket plates, which widen anteriorly, ending in front of the sockets in broad, tooth-like projections, from the lower angle of which rise the spires, each consisting of sixteen or more coils. The first coil bears a small triangular spur near the middle of its first half.

Dimensions very variable; three examples measure as follows:—

Length 28 mm.; width 35 mm.; thickness 18 mm.

“ 25+ “ “ 63 “ “ 23 “

“ 42 “ “ 68

The Brazilian specimens of this species vary extremely, not only in general shape, but in the size and form of the plications, which, in some examples, are narrow and rounded, while in others they are much broader and flattened. Their fasciculated arrangement is also a variable character, some specimens scarcely showing a trace of it, and in none is it as strongly developed as in many of the North American examples. The granules were only observed on one specimen, having disappeared from the others by partial exfoliation. The internal characters vary considerably in the form of the muscular area, and in the extension and prominence of the dental plates, the latter being much affected by the thickening of the valve.

Through the kindness of Prof. Orton, I have had an opportunity of examining specimens from Peru, which agree well with the figures and descriptions of *Spirifer Condor*, d'Orbigny, but are undoubtedly identical with the Brazilian

and North American forms. They are labelled Pichis River, Ucayali, Peru, and were associated with *Eumetria punctulifera*, and other forms mentioned on page 7.

POSITION AND LOCALITY.—This species occurs quite abundantly in the Coal Measures limestone at Bomjardim, and on the beach at Itaitúba. A few specimens from the silicious boulders probably belong to this species, though they have much the appearance of *S. opima*.

SPIRIFERA OPIMA, Hall, Pl. I, Fig. 4; Pl. II, Fig. 7; Pl. IV, Fig. 12.

Spirifer opimus, Hall, 1858, Geol. Sur. of Iowa, Part 2, p. 711, Pl. XXVIII, Fig. 1.

Shell of medium size, subcircular or subelliptical, gibbous, the valves being about equally convex; length and width about equal, but usually slightly transverse; length of hinge line generally somewhat less than the greatest width, which last falls near the middle of the shell; cardinal extremities obtuse or rounded.

Ventral valve most convex a little posterior to the middle, rounding more or less abruptly from thence to the front and sides; mesial sinus narrow and sharply defined at the beak, becoming quite broad and usually less well defined at the front, marked at first by a single plication at the bottom, on each side of which others are added, by the occasional bifurcation of the plications bounding the sinus, until, at the front of the larger specimens, the number is increased to about seven; beak prominent, strongly incurved, apex pointed; area extending to the cardinal extremities, triangular, moderately high in the middle, concave, the upper portion curving with the beak, vertically striated; foramen large, triangular, rather higher than wide, and margined by a slight groove.

Dorsal valve highest at the middle, the slope from thence to the sides being nearly straight, and often quite abrupt; beak slightly elevated and incurved over a narrow area furnished with a small fissure; mesial fold sharply defined, more or less angular, marked near the beak by a single plication to which five or six others are added by bifurcation.

Surface ornamented on each side of the fold and sinus, by about twelve, prominent, more or less angular plications, separated by equivalent reverse plications. The plications are simple, with the exception of one or two at the sides of the fold and sinus, which usually bifurcate.

In the interior of the ventral valve, the dental plates are more or less extended, partially enclosing the narrow, elongated, depressed muscular area. The oclusors are very long and narrow, extending considerably beyond the middle of the valve. The divaricators are broader and shorter, enclosing the posterior portion of the oclusors.

Two specimens measure as follows:—

Length 20 mm. ; width 22 mm.

“ 26 “ “ 30 “

A specimen partially obscured in the matrix, but apparently belonging to this species, is considerably larger than those above given.

This species appears to have attained a somewhat greater size in Brazil than in North America. Otherwise the specimens from Itaitúba agree with the typical forms of the species with which they were identified by Prof. Hall.

POSITION AND LOCALITY.—Coal Measures, in the limestone at Bomjardim and Paredão, on the beach and in the silicious boulders at Itaitúba.

Sub-Genus MARTINIA, McCoy.

SPIRIFERA (MARTINIA) PERPLEXA, McChesney, Pl. III, Figs. 27, 39, 40, 45, 50; Pl. VIII, Fig. 13.

Spirifer perplexa, McChesney, 1859. Desc. of New Pal. Fossils, p. 43.

S—— *lineatus*, Shumard, 1855, Geol. Sur. of Missouri, p. 216; Hall, 1856, Pac. R.R. Rep't, Vol. III. p. 101, Pl. II, Figs. 6, 7, and 8; Marcou, 1858, Geol. of North America, p. 50, Pl. VII, Fig. 5; Norwood, 1872, Geol. Sur. of Missouri, p. 417. (Not *Spirifer lineatus*, Martin.)

S—— *lineatus?* Meek, 1864, Geol. Sur. of Cal., Vol. I, p. 13, Pl. II, Fig. 6; and 1872, Final Report of Geol. Sur. of Nebraska, Pl. II, Fig. 3.

Shell small, thin, subcircular or subelliptical in outline, a little wider than long, double convex; hinge line much

shorter than greatest width; cardinal extremities broadly rounded.

Ventral valve gibbous and much more convex than the the dorsal, greatest convexity between the beak and middle; beak prominent, subconical, projecting considerably behind the hinge line, strongly incurved, with the pointed apex directed forwards; area triangular, strongly concave, cardinal margins indistinct, in some cases obsolete, the surface under the beak being somewhat flattened, but not forming an angle with the body of the shell; fissure large, nearly as wide as high, margined by a thin, prominent ridge.

Dorsal valve moderately convex, beak pointed, slightly elevated above the hinge line, from which it is separated by a narrow, triangular area, with a broad and low triangular fissure, partially concealed by a slight incurving of the beak.

Surface of both valves ornamented with numerous, slightly raised, concentric ridges of growth, about seven of which, at the margin, occupy a space of 5 mm. Along each ridge runs a row of closely set, minute, flattened spines directed forwards, the bases of which sometimes give the ridges a crenulated appearance.

In the interior of the ventral valve, a narrow ridge extends along each margin of the fissure from the tooth to the beak. The muscular area is long, and fusiform, extending beyond the middle of the valve. The central scar, (of occlusors), is single and narrow, the divaricators forming on each side a somewhat broader impression, that becomes slender and pointed anteriorly.

In the dorsal valve, a moderately broad socket plate extends along each margin of the fissure from the socket to the beak, but is not attached to the bottom of the valve. This plate widens considerably anteriorly, and the inferior angle is considerably produced beyond the socket, to give attachment to the simple spiral arms, each of which consists of more than six coils. Muscular area subelliptical, and shorter than in the ventral valve.

The following are measurements of three examples:—

Length, 15 mm.; width 16 mm.; thickness 9 mm.

"	18	"	"	21	"
"	16	"	"	19	"

The form to which the Brazilian specimens, above described, belong, occurs quite abundantly in the Coal Measures of North America, and has usually been identified with *Spirifer lineatus*, Martin, to young specimens of which it bears a very close resemblance. Since no American specimens of this form seem to have ever attained a greater size than that of the second specimen of which measurements are given above, we may justly conclude that we know the American form in its adult condition, and we should therefore compare it, not with the young of *S. lineatus*, but with full grown individuals of that species. Besides the great difference in size, our specimens differ in the following particulars from authentic, adult examples of Martin's species from Ireland: the shape is less transverse, there is no trace of a sinus, and the ornamentation, while agreeing in general character with *S. lineatus*, is much more delicate, being never sufficiently prominent to produce the rugose appearance characteristic of that species. Through the kindness of Prof. St. John, I have had an opportunity of studying young specimens of Martin's species from Yorkshire, England, belonging to the collection of the Museum of Comparative Zoölogy, Cambridge, Mass. The specimens are of about the same size as the largest example of *S. perplexa* from Brazil, from which last they exhibit similar, though of course less marked differences. Not having seen specimens or figures of McChesney's types, the name has been adopted on the authority of Mr. Meek, who figures in the California and Nebraska Reports, a shell which he identifies with McChesney's species, referring it, however, with doubt to *S. lineatus*.

The Brazilian specimens differ from the North American forms only in the strength of the crenulations of the ridges produced by the insertion of the spines, which in no instance extend from ridge to ridge, forming continuous lines, such as I have observed on specimens from Kansas.

POSITION AND LOCALITY.—Coal Measures. In the limestone at Bomjardim, and on the beach at Itaitúba. I have also recognized this species in the rock from the Pichis River, Peru.*

SPIRIFERA (MARTINIA) PLANOCONVEXA, Shumard. Pl. VIII, Figs. 12, 16, 18; and Pl. IX, Fig. 7.

Spirifer planoconvexus, Shumard, 1855, Geol. Sur. of Missouri, p. 202: Meek and Hayden, 1865, Paleont. Upp. Missouri, Part I, pp. 20 and 21, Figs. a, b, c, d, e: Geinitz, 1866, Carb. and Dyas in Neb., p. 42, Tab. III, Figs. 10-18.

Ambocalia gemmula, McChesney, 1859, Desc. New Pal. Foss., p. 41: also, 1865, illustrations of same, Pl. I, Fig. 3, a, b, c.

Martinia planoconvexa, McChesney, 1869, Trans. Chicago Acad. Sci., Vol. I, p. 34, Pl. I, Fig. 3.

Spirifer (Martinia) planoconvexus, Meek, 1872, Final Report of Geol. of Nebraska, p. 184, Pl. IV, Fig. 4; Pl. VIII, Fig. 2.

Shell very small, transversely subelliptical, greatest width near the middle of the shell, double convex, the valves differing greatly in convexity; hinge line straight, always less than the greatest width, with rounded cardinal extremities; lateral and frontal margins strongly rounded, forming a flattened elliptical curve.

Ventral valve very gibbous in the umbonal region, the convexity decreasing somewhat towards the front and sides; beak prominent and elevated, extending considerably beyond the hinge, strongly incurved, the apex being pointed and bent forwards; area well defined, triangular, usually wider than high, making nearly a right angle with the plane of the margins of the valves, but arching considerably with the curvature of the beak; foramen large, triangular, usually higher than wide, margined by slightly elevated ridges, the apex under the beak being sometimes closed by the approximation of the dental ridges, forming a sort of pseudo-deltidium.

The dorsal valve has the form of a flattened ellipse, truncated on one side by the hinge line, and is moderately convex, the convexity being most pronounced in the umbonal region, often becoming nearly flat, very rarely concave, at the

* See page 6.

margin, the whole valve appearing very flat in comparison with the inflated ventral valve; beak small, passing slightly beyond the hinge line, not incurved; area very low, triangular, extending to the cardinal extremities; fissure small, triangular, bordered by slight marginal ridges.

In the interior of the ventral valve, the margins of the fissure are thickened and prolonged inward as strong ridges, which support the teeth. The muscular area is narrow, elongated, extending nearly to the front of the valve. Two pairs of muscular scars are distinguishable, the inner, or those of the occlusors, being very narrow and elongated, while the outer, or those of the divaricators, are narrow, semioval, and about two-thirds as long as the inner pair.

In the dorsal valve the socket plates are tooth-like, and prolonged backward, meeting at the beak, a small, pointed cardinal process being situated in the angle between them. From the front of each plate a slender process, for the support of a spiral arm, extends forward close to the bottom of the valve. Muscular area elongated, extending to, or beyond the middle of the valve, and composed of a narrow, median impression with a similar one on each side.

Two examples measure as follows:—

Length 6 mm.; width 7 mm.; thickness 4 mm.

“ 7 “ “ 9 “ “ 5 “

The Brazilian specimens above described, differ but slightly from the North American forms of the species. In the former the dorsal valve is never exactly plane and it is only very rarely concave at the margins, and among a large number of well preserved specimens, there is no indication of a mesial depression in the ventral valve.

S. planoconvexa resembles, somewhat, the young of *S. perplexa* and, without some care, the two species are liable to be confounded. In its earlier stages of growth *S. perplexa* shows the distinguishing characteristics of the species in the form of its beak, the convexity of its dorsal valve, and its peculiar surface markings, features which readily distinguish it from *S. planoconvexa*.

POSITION AND LOCALITY.—This species is abundant in the Coal Measures limestone at Bomjardim. A few specimens were found on the beach at Itaitúba. A very small specimen obtained from the pebble brought from the Pichis River, Peru, by Prof. Orton appears to be the young of *S. planoconvexa*.

Genus SPIRIFERINA, d'Orbigny.

SPIRIFERINA TRANSVERSA, McChesney, sp. Pl. II, Figs. 4, 5, 6, 13; Pl. III, Figs. 12, 13, 14, 17; Pl. V, Fig. 4.

Spirifer transversa, McChesney, 1859, New Palæozoic Fossils, p. 42.

Shell of medium size, varying in outline from semicircular to subfusiform, gibbous, both valves strongly convex; greatest width at the hinge line, which is often much extended and mucronate.

Ventral valve more convex than the dorsal, greatest elevation in the umbonal region, slope to the front abrupt, and but little curved; extremities of mucronate specimens flattened; sinus deep, subangular, narrow near the beak, but expanding considerably at the front, with a small, well-defined rib at the bottom; beak strongly elevated, prominent, more or less incurved, the apex being pointed; area usually moderately high, with nearly straight cardinal margins; fissure triangular, large, usually higher than wide, margined by a slight groove.

Dorsal valve quite regularly arched from beak to front, highest at the middle; beak broad, slightly incurved, and projecting beyond the hinge line; area narrow, curving with the beak; fissure low, moderately broad, margined by a groove; mesial fold prominent, rather narrow, flattened at the summit, usually with a slight depression in the centre, beginning near the beak and extending to the front.

Surface ornamented with moderately strong, narrow, subangular, simple plications, separated by reverse plications of equal strength, usually numbering from eight to twelve on each side of the fold and sinus, but, in the elongated forms, the number is increased to eighteen or more. Crossing the

shell are numerous, closely arranged, regular, subimbricating, concentric lamellæ, which, in arching over the plications, follow a zigzag course; shell structure coarsely punctate, the punctures being rather distant, and, where well preserved, visible without the aid of a magnifier.

In the ventral valve, the dental plates are large, extending to the bottom of the valve in front of the teeth. They are usually strongly curved, converging from the margin of the fissure for about half their length, and then diverging to the base. Between the dental plates is a high, thin mesial septum rising, near the middle of the valve, in an acute, elevated point, the posterior end of the septum being united with a more or less well developed, concave pseudo-deltidium, filling the apex of the fissure.

In the dorsal valve, the apex of the fissure is occupied by a comparatively large, solid, grooved cardinal process, from the base of which the socket plates extend horizontally, on each side, along the margins of the fissure, rising in tooth-like projections in front of the sockets, and often uniting in the middle, forming a continuous transverse plate. At the bottom of the fold a very low, thin mesial septum extends nearly to the middle of the valve, separating the muscular scars.

Four examples measure as follows:—

Length 16 mm.; width at hinge 26 mm.; thickness 13 mm.

"	15	"	"	"	34	"	"	15	"
"	12	"	"	"	19	"	"		
"	16	"	"	"	45±	"	"		

The last measurement is estimated from the half of an extremely elongated specimen.

The Brazilian specimens referred to this species appear to combine many of the characters of *S. transversa*, McChesney, and *S. kentuckensis*, Shumard. While they agree with the former in the number and shape of the plications, and in the presence of a small rib in the sinus, with a corresponding depression in the fold, they resemble the latter in the height of the area and in their general form. In their posterior aspect the resemblance to *S. kentuckensis* is very close, but the plications are smaller and more numerous than in that species.

Prof. Hall and Mr. Whitfield, who have kindly examined the Amazonian forms, express themselves satisfied as to their identity with McChesney's species, since they have seen specimens of the latter from typical localities, that bear a stronger resemblance to the Brazilian forms, in those characters in which they approach *S. kentuckensis*, than do the type specimens of *S. transversa*.

POSITION AND LOCALITY.—Coal Measure; in the limestone at Bomjardim, and loose on the beach at Itaitúba. In North America this species has so far been found only in the Chester limestone.

SPIRIFERINA SPINOSA, (?) Norwood and Pratten, sp. Pl. VI, Figs. 8, 13, 14.

Spirifer spinosus, Norwood and Pratten, 1854, Jour. Acad. Nat. Sci., Phil., p. 71, Pl. IX, Fig. 1: Hall, 1858, Geol. of Iowa, p. 706, Pl. XXVII, Fig. 5.

Shell small, gibbous, semielliptical in outline, slightly wider than long; hinge line equal to, or greater than the width at the middle of the shell; cardinal extremities rounded.

Ventral valve more convex than dorsal, highest a little in front of the pointed and slightly incurved beak; area moderately large, curving with the beak; fissure large and higher than wide; sinus deep and rounded, sometimes with an obscure rib in the middle.

Dorsal valve moderately convex; beak projecting slightly beyond the hinge line; fold elevated and but little wider than the plication on each side.

Surface marked, on each side of the fold and sinus, by five or six large, prominent, angular plications, separated by reverse plications of equal strength. Surface pustulose, structure coarsely punctate.

The largest specimen measures as follows:—

Length 14 mm.; width at hinge 15 mm.; thickness 12 mm.

The material representing this species is too imperfect for positive determination, though there can be but little doubt as to its identity with the North American species to which it is referred. The specimens occur mainly in the state of

internal casts, on which the mesial septum, and sometimes the casts of the punctures characteristic of the genus, may be seen. The only specimen showing the exterior is partially exfoliated, rendering the characters obscure, but it nevertheless shows traces of pustules or spines. There are, however, no traces of the regular, concentric lamellæ characteristic of *S. spinosa*. One of the casts shows very distinctly a rib in the sinus, a character I have never seen on the specimens and figures of *S. spinosa* that have come under my observation.

POSITION AND LOCALITY.—Coal Measures. This is one of the rarest Brachiopods at Itaitúba, and has been found only in the chalky, decomposed cherts.

Genus RHYNCHONELLA, Fischer.

RHYNCHONELLA PIPIRA, sp. nov. Pl. III, Figs. 18, 23, 25, 26, 31.

Shell of moderate size, subcordiform to subtrigonal, angular behind, front margin flattened in outline or more or less broadly indented, with the antero-lateral margins well rounded; usually transverse; moderately convex to gibbous, the thickness usually increasing quite regularly from the beak nearly to the front, giving the shell a wedge-like appearance.

Ventral valve depressed, slightly convex near the beak, the sides flat or somewhat resupinate at the margin; middle of the shell flattened and slightly depressed below the sides, near the front, where it is abruptly bent nearly at right angles, indenting deeply the dorsal valve and forming a strongly marked sinus, which, however, does not extend to the umbonal region; beak small, pointed, nearly straight, pierced by a small, circular foramen, below which is a triangular fissure bordered by a small but well marked false area; fissure more or less filled by the beak of the dorsal valve, which, in gibbous specimens, entirely conceals it and forms the front of the foramen.

Dorsal valve gibbous or flattened, always more convex than

the ventral ; fold broad and flat, shown only near the front of the valve, where it rises sharply above the somewhat longer sides, while directly in front it is bent to meet the sinus ; beak broad, flattened or inflated, slightly incurved into the fissure of the opposite valve.

Surface of both valves marked by about sixteen, large, rounded ribs, separated by grooves of considerably less width, radiating from the beak, five of which occupy the sinus and six the fold. All the ribs become enlarged at the margin, where they are usually slightly grooved, and those on the sides of the ventral valve are somewhat bent upward at the extremities. Ribs crossed by fine, close, concentric, zigzag striæ.

Three examples measure as follows:—

Length, 15 mm. ; width, 20 mm. ; thickness, 13 mm.

"	10	"	"	14	"	"	9
"	10	"	"	10	"		

This species appears to be quite distinct from any hitherto described from America. Mr. Whitfield informs me that an identical, or closely related, but undescribed form occurs in the Coal Measures of the Western States. Our species is most nearly related to *R. pleurodon*, Phillips, from which it differs in that the shell is smaller, less transverse, and more triangular in outline, while the ribs are more rounded and the beak more depressed. In *R. pleurodon* the beak is pointed, the foramen being placed below it, and separated from the hinge line by a deltidium, but in our species the foramen truncates the beak and there is no deltidium.

The form from Bolivia, referred to *R. pleurodon* by Salter and Toulà, appears to differ from that species much more than *R. Pipira* does, being plicated only at the margins. The Andean shell is probably more nearly related to *R. osagensis*, Swallow, than to either of the two species above mentioned.

From the pebble brought from the Pichis River, Peru, by Prof. Orton, I have obtained a *Rhynchonella* or (*Camarophoria*?) perhaps identical with the form figured by Salter in the Quart. Jour. Geol. Soc., vol. 17, as *R. pleurodon*.

The word *Pipíra* is the indigenous name of a species of Tanager common at Itaitúba, and is the familiar title applied to our friend and host, Tenente Joaquim Caetano Corrêa, to whose aid our success at Itaitúba was largely due.

POSITION AND LOCALITY.—Coal Measures. From the limestone at Bomjardim, and the white decomposed cherts on the beach at Itaitúba.

Genus CAMARAPHORIA, King.

This genus is represented by fragments of a small species, which, though showing the generic characters very distinctly, are too imperfect for specific determination.

Genus ORTHIS, Dalman.

ORTHIS PENNIANA, sp. nov. Pl. V, Figs. 13, 15, 17, 19, 20, 21, 22; Pl. VIII, Fig. 2.

Shell of medium size, with very thick and heavy valves, double convex, often somewhat flattened and produced at the margins; suboval or ovate in outline, length and breadth nearly equal, greatest width near the front of the shell, and much greater than the length of the hinge line; posterior lateral margins strongly divergent and but slightly curved, lateral margins strongly rounded, front nearly straight, often slightly sinuous.

Ventral valve very slightly convex, nearly or quite flat towards the front; posterior lateral portion descending with a steep, straight slope from the rostral portion of the valve; beak small, pointed, very slightly incurved, not extending backward beyond the beak of the opposite valve; area triangular, sharply defined, rising at first nearly or quite perpendicularly from the dorsal area, which lies in the plane of the margin of the valves, the upper portion curving slightly with the beak; fissure triangular, nearly filled by the projecting cardinal process of the dorsal valve.

Dorsal valve varying from moderately convex to gibbous,

the curvature usually decreasing somewhat towards the front, often with a slight, shallow sinus extending from beak to front ; beak obtusely pointed ; area triangular, flat, and about equal in size to the ventral area ; fissure completely occupied by the large cardinal process, which rises considerably above the surface of the area.

Surface of both valves marked by fine, rounded ribs, separated by sulci of rather less width. The ribs number about sixteen at the beak, but increase by bifurcation, becoming very numerous at the margin, about fifteen of them occupying a space of 5 mm. near the middle of the shell. At frequent, but irregular intervals the ribs are marked by little pits, which undoubtedly bore spines like those of *O. Michelinii*, Lévillé. The valves are also marked by numerous lines of growth. Structure coarsely punctate.

In the interior of the ventral valve the teeth are large and widely divergent, the triangular space enclosed between their bases and the beak being transversely striated for muscular attachment. This corresponds to what Hancock considers to be the pedicle muscular impressions in *O. Michelinii*. In front of the teeth is the large, depressed muscular area, the occlusors forming a single, ovate impression, from the anterior extremity of which extends a large, prominent ridge, separating the anterior portions of the elongated, flabelliform divaricator impressions. The latter are marked by several rather prominent, longitudinal ridges arranged radiatingly with reference to the beak. A portion of the valve in front of the muscular area is pitted with large, shallow, circular depressions.

In the dorsal valve the cardinal process is very large and conspicuous, forming a pyramidal mass with the apex sharply pointed and directed ventrally ; a sharp ridge extends from the apex to the point of the beak, on each side of which is a groove giving the posterior face a trilobed appearance. From each side of the front of the process there rises, in front of the sockets, a broad and stout, irregularly shaped plate that is bilobed at its extremity, and resembles somewhat in outline

a human foot, strongly compressed laterally in the anterior portion. The four muscular scars are rounded and well marked, appearing as if excavated in the substance of the valve, a broad, rounded median ridge being left that extends nearly to the middle of the valve, with a broad lateral ridge on each side separating the scars. A portion of the valve in front of the muscular impressions is pitted as in the ventral valve.

Four examples measure :—

Length, 24 mm.; width 23 mm.; thickness 14 mm.

"	24	"	"	24	"	"	10	"
"	26	"	"	26	"	"	9	"
"	13	"	"	13	"	"	6	" (young).

This species is remarkable for the great thickness of its valves, a feature which can hardly be considered an individual or local peculiarity, for it is a constant character among hundreds of specimens, occurring under the same conditions as the following species of the same genus, which, though much larger, has extremely thin valves. One specimen having a total thickness of 15 mm., has valves which measure 4 and 5 mm. respectively, while the average thickness in the centre of the valve of full grown specimens is from 2 mm. to 3 mm. The thickening is particularly noticeable about the cardinal process and adjoining parts of the dorsal valve.

The outer surface is usually exfoliated so that the spine bases and punctures are seldom seen.

Orthis Penniana is most nearly related to *Orthis Michelini*, Lèveillé, which it resembles in general shape, ornamentation, and interior details. It differs from that species mainly in the thickness of the valves, the thinness (*peu d'épaisseur*) of which is given as a distinguishing characteristic of *O. Michelini* in the *Géologie de la Russie*, p. 186. It differs besides in having the beak and area of the dorsal valve equal to, or greater than the corresponding parts of the ventral valve, while the contrary is the case with the species cited, which is moreover a larger shell.

Dedicated to Senhor D. S. Ferreira Penna, of Pará, author of an important work on the Physical Geography of the Low-

er Amazonas, and a gentleman whose kindness and influence contributed largely to ensure the success of both the Morgan Expeditions.

POSITION AND LOCALITY.—Coal Measures. This species occurs more abundantly than any other Brachiopod, both at Bomjardim and Itaitúba.

ORTHIS (?) MORGANIANA, sp. nov. Pl. III, Figs. 1, 2, 3, 4, 5, 6, 7, 9, 11, 34; Pl. IV, Figs. 6, 14, 15.

Shell large, thin, ventricose or gibbous, semi-circular in outline when regular, but usually more or less distorted; hinge line short, with rounded cardinal angles.

Ventral valve moderately convex in the umbonal region, becoming flat or concave towards the margins, usually with a broad, depressed sinus, beginning near the front and indenting deeply the margin of the opposite valve; beak small, pointed, incurved over the moderately high, triangular area, which rises nearly vertically from the plane of the margins; fissure large, triangular, and usually higher than wide.

Dorsal valve much deeper than the ventral, varying from strongly convex to gibbous, and usually much inflated in the umbonal region; beak small, pointed, and incurved over the low, slightly curved, triangular area; fissure large, triangular, wider than high, open.

Surface of both valves marked by very numerous, minute, rounded ribs, increasing by intercalation and bifurcation, and of which, near the middle of the valve, twenty-five occupy a space of 5 mm. Many of the ribs become swollen, at intervals, the enlargement terminating in an elongated pit or spine-base. The surface is also crossed by numerous fine lines of growth, and, when well preserved, it shows minute, scattered punctures.

In the interior of the ventral valve the teeth are comparatively small, divergent, supported by broad dental plates extending along the bottom, from the beak nearly to the middle of the valve, and enclosing the oblong muscular area, which is divided by a thin, elevated septum, beginning a

short distance in front of the beak, and extending from a third, to half the length of the valve, and rising to a sharp, elevated point near its anterior extremity. On each side, opposite the middle of the septum, are the small, narrow, oblong occlusor impressions, surrounded by the large, elongated, ovate divaricator scars.

In the dorsal valve the apex of the fissure is occupied by a small, multifid cardinal process, which, seen from the front, resembles somewhat a minute hand. Socket plates strongly developed, bordering the fissure and rising in front of the hinge in long processes (arm supports?) that resemble the teeth of the ventral valve, but are larger. These plates, on each side, are prolonged as prominent ridges, which, uniting in front, surround the large, ovate, muscular area. At the front of this area is a pair of deeply impressed, rounded scars, separated by a rather prominent and narrow septum, which becomes obsolete towards the beak. At the sides of the area, obliquely behind these scars, and separated from them by a slight ridge, is a pair of oval pad-like scars, each of which is double, consisting of two, narrow, subparallel grooves, separated by a short, thick ridge. on each side of the median line, in the space between this last pair, and behind the first, is, a large, faint, semioval scar.

Three examples measure:—

Length, 37 mm. ; width, 40 mm. ; thickness, 20 mm.

“ 36 “ “ 38 “ “ 25 “

“ 37 “ “ 33 “ “ 27 “

This species, in its external characters, resembles somewhat closely certain forms of *O. resupinata*, Martin, but in its internal characters it is so peculiar, that, for the present, its generic relations must remain somewhat doubtful.

The three sets of muscles in the dorsal valve, which have been observed in a number of specimens, differ from anything hitherto described in any species of *Orthis*, and if nothing analogous can be proved to exist in the species which appear to be most closely related to it, these points of structure will serve to characterize a new genus. Until, however, the in-

teriors of the related forms are fully known, I have thought it better to refer it provisionally to *Orthis*, rather than introduce a new generic name.

Compared with Davidson's figures of the interior of the dorsal valve of *O. resupinata*, the anterior scars clearly correspond with those which he refers to the anterior oclusors; the lateral double scars correspond in position, though not in form and structure, with those of the posterior oclusors of Davidson. Between the last-mentioned impressions there is, in *O. resupinata*, a broad, open space, apparently raised, which Davidson homologizes with the mesial ridge of *O. Michelini*, but which agrees so nearly in form and position with a similar, though somewhat depressed, space in our species, in which are situated the posterior median impressions above described, that I suspect that similar impressions may exist in Martin's species, though hitherto undetected. If this surmise be correct, our species will not be found to differ generically from *O. resupinata*; but the two species, and perhaps others of the resupinate group, should be separated from *Orthis* as a generic group, to which King's name, *Schizophoria*, typified by *O. resupinata* (Mon. Perm. Foss., p. 106), would have to be applied. A comparison of the figures of *O. ? Morganiana* and *O. Penniana*, nob., and of *O. resupinata* and *O. Michelini*, on Pl. XXX of Davidson's Monograph of British Carboniferous Brachiopoda, will, I think, show clearly the necessity of such a separation, in case the two resupinate species can be shown to have a similar internal structure.

On the other hand, the ventral valve has the three laminae, characteristic of Meek and Worthen's genus, *Syntrilasma*,* differing only in being a little less closely approximated, than in the typical species of that group. Taking into account the difference in the size of the specimens of the two species represented on Pl. III, in which Fig. 10 is a ventral valve of *Syntrilasma hemiplicata*, Cox, from Nebraska City, that difference becomes unimportant. In *O. resupinata* there are

* Mr. Meek, in a letter, suggests that this orthography be adopted, instead of *Syntrielasma*.

similar dental plates, though much more widely separated, and less developed, and the mesial septum is represented by a low ridge.

Mr. Meek, having kindly examined some of our specimens, writes as follows:—"Your species stands almost exactly intermediate, as it were, between these forms [Syntrilasma] and the *O. resupinata* group. That is, it has the form of *O. resupinata*, and, like that shell, wants the large plications of the Syntrilasma group; while its internal laminae of the ventral valve are intermediate in character, though certainly much more nearly like those of Syntrilasma. My present impression is, in the light of the new information given by your species, that Syntrilasma may more properly form a sub-genus of *Orthis*."

Mr. Meek wrote the above from an inspection of the ventral valve alone. After examining the dorsal valve of our species, he appears to be of the opinion that the dorsal valve of Syntrilasma, which is unknown, will prove to be as closely related to that of the Brazilian form, as is the ventral valve; and that, in this case, our species will fall into Syntrilasma, and this genus will require to be entirely separated from *Orthis*.

This beautiful species is, at the suggestion of Prof. Hartt, dedicated to Col. E. B. Morgan, of Aurora, N. Y., who contributed generously to the fitting out of the two expeditions that bear his name.

POSITION AND LOCALITY.—Coal Measures. This species occurs quite abundantly in the limestone at Bomjardim, and on the beach at Itaitúba.

Genus STREPTORHYNCHUS, King.*

STREPTORHYNCHUS CORREANUS, sp. nov. Pl. VI, Fig. 11; Pl. VII, Figs. 1, 2, 3, 4, 8, 10, 11, 12, 13, 14, 17.

Shell large, unsymmetrical, usually much distorted, transversely subelliptical when regular; length of hinge line less than greatest width of shell.

* Though I have not seen Pander's work, there are reasons for doubting the identity of his genus, *Hemipronites*, with the group for which King subsequently

Ventral valve flattened, more or less strongly curved from side to side, the slope from the beak to the margins being nearly straight; beak pointed, strongly twisted, and often highly elevated; area variable in height and inclination, being sometimes of moderate height, and rising nearly perpendicularly from the plane of the margin, more often very high, acutely triangular, and inclined backwards at a considerable angle, furnished in the middle with a high, triangular, convex pseudo-deltidium, coarsely striated transversely, the area being striated in the opposite direction.

Dorsal valve quite regularly subelliptical in outline, varying from strongly convex to ventricose; umbonal region usually broadly inflated, often extending slightly backward beyond the hinge line; posterior lateral portions of the valve flattened near the cardinal extremities.

Surface of both valves ornamented by numerous, fine, prominent, rounded ribs, of which from eight to ten occupy a space of 5 mm. These increase by interstriation, and are separated by sulci equal to them in width. The intercalated ribs are usually a little smaller than the older ones, giving an irregular, alternating appearance to the ornamentation.

In the interior of the ventral valve the dental plates are strongly developed and united by their anterior margins, within the apex of the beak, with the end of a high, blade-like mesial septum, which extends nearly to the middle of the valve, a small, conical cavity being thus formed, within the

proposed the name, *Streptorhynchus*. The typical species, *Hemipronites tumidus*, is placed by Murchison, de Verneuil and von Keyserling as a synonym of *Orthis hemipronites*, von Buch (Géol. de la Russ., p. 205). In the Jewett Collection of the Cornell University Museum, there are two beautiful specimens from St. Petersburg, bearing the latter name, and agreeing perfectly with the figures and descriptions given by the authors cited. The specimens were received from M. de Verneuil, and were undoubtedly named by him. They show the foramen characteristic of *Orthisina*, at the apex of the pseudo-deltidium, and are, therefore, quite different from the type of King's genus.

Since the above was in type, Mr. Meek writes me as follows:—"In regard to *Hemipronites*, I would remark that, in Russia, they often confound that type with *Orthisina*. I have a fine series of Russian Silurian and Carboniferous Brachiopoda, sent to me by Col. Romanowski, and I have no doubts about *Hemipronites* being in all respects congeneric with *Streptorhynchus*, King." As this opinion in regard to Pander's type is directly opposed to that of de Verneuil, I shall, for the present, adopt the name *Streptorhynchus*, provisionally, not having at hand the proper material to enter into a question on which two such eminent paleontologists disagree.

beak, between the pseudo-deltidium and the united margins of the septum and dental plates. On each side of the septum is a large, flabelliform muscular impression, probably consisting of two parts, but the division is not distinctly marked.

In the interior of the dorsal valve the cardinal process is long, bifid, curving considerably backward beyond the hinge, and uniting at its base with the large, diverging socket plates, which, on each side, are continued along the bottom of the shell in a ridge, that borders the large, ovate, muscular area, which last is sometimes divided by a slight median ridge.

Dimensions very variable; four specimens measure:—

Length 28 mm.; width 33 mm.; thickness 16 mm.

"	47	"	"	60	"
"	43	"	"	48	"
"	55	"	"	45	"

Several fragments show that the species sometimes attained a still greater size.

As indicated above, this species is extremely variable in form and proportions, owing to the distortion of the ventral valve, whose beak, in some cases, appears to have been twice twisted. In large specimens of nearly regular form the area is about 5 mm. high, its length about equaling the greatest width of the valve; but in many of the distorted forms its height is nearly three times as great, and the length is much less than the width farther forward, being about equal to the height of the area. The dorsal valve is much more constant in its characters than the ventral, being usually quite regularly subelliptical in outline, and regularly convex or ventricose. The cardinal process is well shown on several casts; but there are unfortunately none that will admit of being introduced into a photographic plate. The figures of the species next to be described will, however, serve to illustrate its character, for the processes in the two species are similar in form.

Interiorly this species is remarkable for the large ventral septum, as well as for the extension of the dental plates and their union with the septum, forming a small chamber within

the beak. Prof. Hall agrees with me in thinking that these characters are sufficient to distinguish our species from the others of the genus hitherto described, only three of which, viz.: *S. (Hemipronites) crassus*, Meek and Hayden, *S. robusta*, Hall, and *S. senilis*, Phillips, are known to have a ventral septum. In the latter species the septum appears to have been completely overlooked by European palæontologists, though well shown on a number of specimens from de Koninck's collection, loaned me by the Museum of Comparative Zoölogy.

I take great pleasure in dedicating this species to the brothers José, Francisco and Joaquim Caetano Corrêa, of Santarem and Itaitúba, to whose hospitality and kindly aid much of the success of our two trips on the Tapajos was due.

POSITION AND LOCALITY.—Coal Measures. As yet this species is only known with certainty from the large silicious boulders at Itaitúba, where it occurs very abundantly in the state of casts.

STREPTORHYNCHUS HALLIANUS, sp. nov. Pl. V, Figs. 1, 2, 5, 8, 12, 14, 16, 18; Pl. VIII, Fig. 3.

Shell large, unsymmetrical, pecten-shaped, usually rather wider than long; length of hinge line considerably less than the greatest width of the shell; cardinal angles obtuse.

Ventral valve scarcely curved from beak to front, more or less arched transversely, the posterior lateral portions being generally much inclined from the general plane of the valve; beak prominent, elevated, pointed, more or less twisted; area high, triangular, more or less inclined backward from a perpendicular to the plane of the margin, striated across its length; fissure completely closed by a triangular, convex pseudo-deltidium.

Dorsal valve regularly and strongly convex, or gibbous, with a distinct alation at the cardinal angles.

Surface of both valves ornamented with small, rounded ribs, numbering about sixteen at the beak, but increasing by interstriation to about one hundred and fifty at the margins,

where from ten to twelve occupy a space of 5 mm.; primary ribs considerably more prominent than the intercalated ones; interspaces about equal in width and depth to the ribs. At the margin, in many specimens, the ribs are grouped in large plications, which, however, do not extend far towards the beak.

In the interior of the ventral valve the hinge teeth are large and divergent, the dental plates being but slightly developed and becoming obsolete within the beak. The muscular area is large, ovate, and bounded by an obscure ridge, but it is not divided by a septum. The muscular scars are not well separated, but there appears to be a narrow, oblong mesial impression, due to the occlusors, outside of which are the fan-shaped divaricator impressions. A small space in front of the muscular area is pitted, probably by vascular impressions.

In the dorsal valve the long and large cardinal process extends nearly to the apex of the ventral beak, rising straight from the hinge line, or, at its extremity, bending more or less back of the hinge. The posterior face of the process has a deep groove, extending from the hinge line to the extremity, which it divides into two short prongs, each of which is again grooved at the end. Anteriorly, the process is united with broad, diverging socket plates, from which slight ridges are prolonged, surrounding the muscular area, which is usually divided by a low septum having an oval impression on each side.

The following are measurements of two examples:—

Length 31 mm.; width 35 mm.

“ 30 “ “ 31 “

This species is clearly separated from *S. Correanus*, nob., by the absence of the ventral septum, and the lesser development of the dental plates, particularly within the beak. Associated with these internal differences, are the peculiar pectenoid form and short hinge line of *S. Hallianus*. The dorsal valves of the two species are almost precisely alike interiorly, and in the character of the cardinal process, they resemble *S. senilis*, Phillips, as will be seen in Pl. VII, Fig. 9, which repre-

sents a fine cast of that species, from Visé, Belgium, from the de Koninck Collection in the Museum of Comparative Zoölogy. Our species somewhat resembles in form the one just named, but it is much more coarsely striated, and the hinge is proportionally shorter, while, interiorly, *S. senilis* is provided with a prominent septum in the ventral valve, which is well shown on several specimens from the de Koninck Collection. The pectenoid shape is also characteristic of *S. pectiniformis*, Davidson, from the Punjaub, India, and *Meckella* (*Streptorhynchus*?) *striato-costata*, Cox, from the Western Coal Measures. Our species shows a decided tendency towards the formation of the peculiar plications characterizing both these species, though the plications are never sufficiently developed to warrant its identification with either.

Dedicated to the distinguished palæontologist, Prof. James Hall, of Albany, N. Y., who has contributed much to our knowledge of the genus *Streptorhynchus*.

POSITION AND LOCALITY.—Coal Measures; in the limestone at Bomjardim, and on the beach at Itaitúba.

STREPTORHYNCHUS TAPAJOTENSIS, sp. nov. Pl. V, Figs. 3, 6, 7, 9. 10; Pl. VIII, Fig. 9.

Shell depressed, plano-convex or concavo-convex, subelliptical in outline, more or less unsymmetrical; length of hinge line equal to, or slightly less than the greatest width of the shell anterior to that line; cardinal extremities right angled or slightly obtuse; frontal margin rounded, sometimes slightly sinuous.

Ventral valve usually slightly convex in the umbonal region, becoming flat or concave in the middle and towards the front; beak pointed, moderately elevated above the hinge line, more or less distorted and twisted to one side; area narrow, triangular, rising vertically, or with a backward inclination, from the plane of the margin; fissure moderately large, triangular, and nearly closed by a convex pseudo-deltidium, the base of the fissure being occupied by the projecting cardinal process.

Dorsal valve usually symmetrical, moderately and regularly

convex, with a slight flattening near the cardinal extremities, and sometimes a slight depression along the middle; hinge line bordered by a narrow, linear area, from the middle of which projects a broad, rather narrow, convex plate or pseudo-deltidium, that surrounds the end of the projecting cardinal process. The area is often concealed by the overlapping of the valves.

Surface of both valves marked by narrow, rounded, radiating ribs, separated by sulci of rather greater width. The ribs number about twenty at the beak, but, at various distances from the beak, they increase by interstriation, until there are about a hundred at the margin, where from eight to ten occupy a space of 5 mm. The earlier formed ribs are slightly more prominent than the intercalated ones; but the difference between them is less than in the two preceding species.

In the interior of the ventral valve the teeth are moderately large and strongly divergent, the dental plates being but slightly developed, and obsolete at the apex of the beak. A short, slender septum separates the small, semi-oval occlusor impressions, outside and in front of which are the indistinct flabelliform scars of the divaricators.

In the interior of the dorsal valve the cardinal process is broad, thick and short, projecting somewhat beyond the hinge, and divided by a broad, deep notch into two parts, each of which is broadly grooved at its extremity. Surrounding the end of the process, and uniting with it at the sides, just within the sockets, is a thin plate, or pseudo-deltidium, from the middle of which a thin lamina or septum extends forward to be attached to the bottom of the notch; this septum is apparently continuous with a prominent projection on the middle of the concave, anterior face of the septum. The sockets are deep and large, with small socket plates united with the edges of the cardinal process. Muscular area broadly ovate, pointed in front, rarely divided by a slight mesial septum.

Three examples measure :—

Length 30 mm. ; width 39 mm. ; thickness 4 mm.

" 29 " " 34 " " 7 "

" 22 " " 27 " " 5 "

This species is distinguished from the preceding by its depressed form, more extended hinge line, double area, and coarser and more regular ornamentation, characters that are always associated with important differences in internal structure. The distinguishing characteristics of the interior of *S. Tapajotensis* are the low, depressed cardinal process and the ventral mesial septum.

Our species is most nearly related to the European *S. crenistria*, Phillips, and it may prove to be only a variety of that species. It differs from it in never attaining so great a size, and in being more coarsely ribbed, the ribs not alternating, as in that species, and not being crenulated. Interiorly the cardinal process resembles closely that figured by Mr. Davidson in his Mon. Brit. Carb. Brach., Pl. XXVI, Fig. 6; but the muscular impressions are not separated by a broad, prominent ridge, as in that and other specimens figured by Mr. Davidson.

Prof. Hall, on examining the specimen figured in Pl. V, Fig. 3, remarked that it presented a striking resemblance to *S. Pandora*, Billings, from the Upper Helderberg rocks of New York.

POSITION AND LOCALITY.—Coal Measures; abundant in the limestone at Bomjardim and on the beach at Itaitúba.

Remarks on the genus Streptorhynchus.—The study of the three forms above described throws much light on the characters and specific relations of the members of this very perplexing genus. Though presenting internal differences which might perhaps be considered of generic importance, and though each type of internal structure has, constantly associated with it, certain external peculiarities, yet the exteriors are so similar in general character, and so many apparently intermediate forms have been produced by distortion, that, without a knowledge of the interiors, no satisfactory separation of the three forms would have been possible. Regarding external

characters alone, and uniting all the Brazilian forms in one species, as would be necessary in this case, it would be difficult, if not impossible, to indicate good characters to separate that species from either *S. crenistria*, *S. umbraculum*, or *S. chemungensis*, as those species are at present understood. Each of these species contains forms very similar to one or another of those occurring at Itaitúba, and each contains forms, whose association, judged by internal characters, is apparently as unnatural as would be the association of all the Brazilian forms into one species.

The most important internal character presented by our three species consists in the structure of the cardinal process, of which we have two very distinct types presented, the differences between which may be of more than specific importance. That of *S. tapajotensis* is broad, depressed and short, corresponding to the depressed form of the shell in which it is found; it projects backward past the hinge, where it is protected by a pseudo-deltidium or callosity, but it does not extend into the beak of the ventral valve; the socket plates are not prolonged to enclose the muscular area. This type of process has been found in *S. crenistria*, Phillips* (not *S. crenistria*, Aucts.); *S. arctostriata*, Hall, and *S. Pandora*, Billings, (*S. chemungensis*, var. *arctostriata* and var. *Pandora*, Hall);† and *S. Agassizii*, Hartt.‡

The process of *S. Hallianus* and *S. Correcanus* is long, rising perpendicularly from the hinge, though often bent backward at the extremity; it extends almost to the apex of the ventral beak, is deeply grooved on its posterior face, and unites with large socket plates that enclose the muscular area. A similar form has been found in the type of the genus, *S. pelargonatus*, Schloth.,§ *S. devonicus*, d'Orb.,|| *S. (Hemipronites) crassus*, Meek and Hayden,** and *S. chemungensis*, Conrad.††

* Davidson's Mon. Brit. Carb. Brach., Pl. XXV, Fig. 18; Pl. XXVI, Fig. 6; Pl. LIII, Fig. 3.

† Pal. of N. Y., Vol. IV, Pl. IX, Figs. 4, 5, 7, 21; Pl. IV, Fig. 14.

‡ Bull. Buf. Soc. Nat. Sci., Vol. I, No. 4, p. 249. I have seen it very distinctly on specimens of this species in the museum of the Cornell University.

§ Davidson's Mon. Brit. Perm. Brach., Pl. 2, Figs. 38, 39.

|| Davidson's Mon. Brit. Perm. Brach., p. 29.

** Pal. Upp. Missouri, Pl. I, Fig. 7 d.

†† Pal. of N. Y., Vol. IV, Pl. X, Figs. 9, 24.

I have seen the process of the latter species in specimens in the Jewett collection of the Cornell University Museum, much more distinctly than it is shown in the figures cited. I have also observed a similar process in several specimens of *S. senilis*, Phillips, from Visé, Belgium, from de Koninck's collection in the Museum of Comparative Zoölogy, one of which is introduced for comparison on Pl. VII, Fig. 9. A similar process exists in *Meekella striato-costata*, Cox. Many of the characteristic features of the last species, relied on in establishing the genus *Meekella*, are found in a less degree of development in one or the other of the two larger species from Brazil, showing a closer relationship than would have been suspected from the previously known species. *S. Hallianus* resembles the type of *Meekella* in general form, in the plicated surface and in the absence of a ventral mesial septum; but its dental plates are like those of the type of *Streptorhynchus*. On the other hand, *S. Correas*, while exhibiting the characters of the last genus in all other particulars, has the dental plates much more extended than is usual in *Streptorhynchus*, and, in that character it stands intermediate between two forms, or genera, if *Meekella* be really a distinct genus.

Genus CHONETES, Fischer.

CHONETES AMAZONICA, sp. nov. Pl. VI, Figs. 3, 12, and 19;
Pl. IX, Figs. 8, 9.

Shell of medium size, subsemicircular in outline, length of the hinge line equal to, or slightly less than the greatest width of the shell; lateral margins strongly rounded, meeting the hinge line nearly at right angles; frontal margin moderately and regularly rounded.

Ventral valve nearly flat, sometimes slightly depressed along the middle of the front, but without a distinct sinus; beak obtusely pointed, not projecting beyond the cardinal margins, which last bear, on each side, from six to eight slender spines. The latter are indicated by casts of their tubular prolongations which pierced the substance of the shell. The

tubes nearest the beak are strongly inclined towards it, and are set close together, but towards the cardinal extremities they are farther separated, less inclined, and their extremities are bent outwards, indicating that the spines were directed away from the beak. Area narrow, triangular, forming, with the narrow, linear dorsal area, a flat surface perpendicular to the plane of the margin; fissure triangular, low, filled with the projecting process of the nearly flat dorsal valve.

Surface smooth, showing, under a lens, numerous pits, or spine bases (?), and faint traces of striation, probably due to the radiating arrangement of the granules of the interior, and not properly a character of the external surface, like the ribs usually found in species of this genus.

In the interior of the ventral valve a slender septum extends from the beak beyond the middle of the valve, separating the narrow, elongated scars of the oclusors; outside of and longitudinally parallel with which, are the broad, flabelliform divaricator impressions. The entire internal surface is marked by rather large pustules, arranged in lines, radiating from the beak. The pustules increase considerably in size, over an elevated ridge, extending parallel with and close to the margin, where they are smaller and less elevated than on the ridge.

In the dorsal valve the cardinal process is multifid, its base uniting with two curved lateral processes, enclosing the sockets. Muscular impressions, consisting of two, oblique, subparallel scars, near the beak, on each side of a slender mesial septum; between these scars originates the broad, curved, reniform impression, which covers a great part of the lateral portion of the valve. Internal surface pustulose, as in the ventral valve, but without the marginal ridge.

Two specimens measure:—

Length 9 mm.; width 13 mm.

“ 10 “ “ 15 “

This species is closely allied to *C. glabra*, Geinitz, by the smoothness and punctate character of its surface. It differs markedly from that species, however, in its general form,

greater size, the flatness of its valves, and the absence of the sinus. Most specimens show no traces of striæ, and on a cast of the exterior, the pits were much more easily recognized than the striæ, showing that the absence of striation is not due to exfoliation.

POSITION AND LOCALITY.—Coal Measures. This species has been met with only in certain white, chalk-like pebbles, which occur on the beach of the Tapajos, near Itaitúba, resulting from the decomposition of a silicious rock. This rock is quite different from the large silicious boulders containing *Streptorhynchus Correanus* and other large fossils.

CHONETES GLABRA, Geinitz, Pl. VIII, Figs. 11, 14, 15, 19.

Chonetes glabra, Geinitz, 1866, Carb. und Dyas in Neb., p. 60, Pl. IV, Figs. 15-18; Meek, 1872, Final Report Geol. Sur. of Nebraska, p. 171, Pl. IV, Fig. 10; Pl. VIII, Fig. 8; Toulà, 1869, LIX Bde. d. Sitzb. d. Kais. Akad. d. Wissensch. (Not *Chonetes glabra*, Hall, 10th Ann. Rept. of State Cab. of Nat. Hist., p. 117.)

Shell small, transversely subrectangular in outline, length of the hinge line equal to, or slightly greater than the width at any other point; lateral margins nearly straight and subparallel, uniting nearly at right angles with the hinge line at the cardinal extremities, and curving strongly anteriorly to join the slightly sinuous front, which is nearly parallel with the hinge.

Ventral valve moderately convex, with a shallow sinus beginning near the beak and widening rapidly towards the front, bounded on each side by a broad, rounded, undefined ridge, extending from the beak to the antero-lateral margins, and outside of which the postero-lateral portions of the shell are much flattened; beak small, pointed, extending slightly behind the hinge line, and not incurved; area narrow, triangular, rising obliquely backward from the plane of the margin; fissure partially closed by a convex, triangular pseudo-deltidium, and partially by the projecting cardinal process of the dorsal valve; cardinal margin armed with four or five slender spines, directed obliquely outward and backward.

Dorsal valve somewhat concave, with slight depressions cor-

responding to the ridges of the ventral valve; area triangular, narrow, and nearly equaling the ventral area in size, the triangular base of the cardinal process projecting from its centre.

Surface of both valves nearly smooth, showing under a lens numerous scattered pits, or spine bases (?), and more rarely, faint traces of striation.

In the interior of the ventral valve the teeth are comparatively large. A short septum divides the indistinct muscular impressions, and the whole inner surface is marked by rounded pustules, arranged in lines that radiate from the beak.

In the dorsal valve a curved lateral ridge, continued from the cardinal process, encloses the sockets. A small, rounded pit intervenes between the front of the process and the origin of the small mesial septum. The whole internal surface is pustulose, as in the other valve.

Measurements of two specimens:—

Length 6 mm.; width 10 mm.

“ 10 “ “ 13 “

The North American specimens of this species that I have seen, have, for the most part, a deeper sinus, and a rather more extended hinge line than the specimens from Itaitúba.

The appearance of striation on this, as on the preceding species, does not appear to be due to true external striæ, but rather to the arrangement of the pustules, which, owing to the thinness of the valves, or the weathering of the surface, may sometimes show on the outside.

The term *glabra* was applied to a Corniferous species of *Chonetes* by Prof. Hall, in the 10th Report of the State Cabinet, but it was subsequently canceled by him, and the shell thus named referred to *C. lineata*, Vanuxem. As the term is not now applied to any other species, and it has become widely known in connection with the form just described, it is probably better to retain it, even though objectionable, rather than introduce confusion by an attempt to substitute another.

POSITION AND LOCALITY.—Coal Measures; in the lime-

stone at Bomjardim, and on the beach at Itaitúba. Toula has identified this species from Cochabamba, Bolivia.

Genus STROPHALOSIA, King.

STROPHALOSIA CORNELLIANA, sp. nov. Pl. III, Figs. 28, 30, 32, 33, 35, 36, 37, 38; Pl. IV, Fig. 5; Pl. VIII, Fig. 17; Pl. IX, Figs. 10, 11.

Shell small, plano-convex, or concavo-convex, irregular in outline, most specimens being more or less distorted; regular forms circular, or ovoid, varying to ovate, or subrhomboidal; usually wider than long; hinge line short, rarely equal to the width at the middle of the shell. Shell attached by the substance of the rostral portion of the ventral valve, the attachment producing a thickened callosity, and, usually, considerable distortion.

Ventral valve strongly and regularly convex, without sinus; beak inconspicuous, or pointed and twisted; area small, narrow, extending backward in the plane of the margin, usually triangular, with the apex truncated, or subrectangular in specimens with an extended hinge line; fissure small, with slightly divergent sides, closed at the apex by a pseudo-deltidium, the remaining space being filled by the cardinal process of the dorsal valve.

Dorsal valve concave, or flat; area narrow, linear, interrupted in the middle by the projecting base of the cardinal process, on each side of which is a small socket, open posteriorly, and articulating with a tooth of the ventral valve.

Surface of the ventral valve thickly covered with long, delicate, hollow spines, distant about 1 mm. from each other, and often attaining a length of half an inch or more. About half of the spines are directed forward, following the curves of the valve; the remainder rise perpendicularly from the surface, their free extremities often bending backward towards the beak. Surface also marked by concentric, wavy lamellæ. Dorsal valve smooth, without spines or lamellæ.

In the interior of the ventral valve the margins of the fis-

sure are prolonged in comparatively large teeth. The occlusors are small, oval, and separated by an obscure ridge. The divaricators are large and oval, extending considerably in advance of the occlusors.

In the dorsal valve the cardinal process is prominent, slender, bifid, uniting at its base with the lateral ridges forming the inner socket walls, and with a slender septum, extending beyond the middle of the valve, and terminating in an elevated point. On each side, in the angle between the septum and the lateral ridge, the muscles have left a small, oval, elevated scar. Reniform impressions large and curved, extending nearly to the front of the valve, the space between and in front of them being minutely pustulose.

Two examples measure:—

Length 14 mm.; width 15 mm.

“ 15 “ “ 13 “

This species is very easily distinguished from all others of the genus by the character of its spines and surface markings. It differs from *S. Goldfussii*, Münster, in having the spines confined to the ventral valve. A single dorsal valve shows four or five, scattered, circular holes, which may possibly have been spine bases, but as a number of other specimens, equally well preserved, do not show this character, the existence of spines on the dorsal valve is doubtful, and if any existed they were far less numerous than those of the ventral valve. From *S. lamellosa*, Geinitz, it differs in not being longitudinally striated. The only Carboniferous *Strophalosia* hitherto described is from India, and is identified by Mr. Davidson with *S. Morrisiana*, King. The Indian form does not show the striation characteristic of *S. Morrisiana*, a character in which it agrees much more nearly with our species, with which it may prove to be identical.

Respectfully dedicated to the Hon. Ezra Cornell, in grateful acknowledgment of the personal interest he has taken in the Geological Department of the University that bears his name.

POSITION AND LOCALITY.—Coal Measures; quite abundant in the limestone at Bomjardim.

Genus PRODUCTUS, Sowerby.

PRODUCTUS SEMIRÉTICULATUS, Martin, sp. Pl. IV, Fig. 8;

Pl. VI, Fig. 18; Pl. VII, Figs. 5, 6, 7, 15, 16.

Anomites semireticulatus, Martin, 1809, Petrif. Derb., p. 7, Pl. XXXII, Fig. 2; Pl. XXXIII, Fig. 4.

A——*productus*, Martin, 1809, ib., p. 9, Pl. XXII, Figs. 1-3.

Productus scoticus, Sowerby, 1814, Min. Conch., Pl. LXIX, Fig. 3; and ib., Pl. 317, Figs 2-4.

P——*antiquatus*, Sowerby, 1814, ib., p. 15, Figs. 1-5: Phillips, 1836, Geol. of Yorks., p. 213, Pl. VII, Fig. 1.

P——*semireticulatus*, de Koninck, 1847, Mon. Gen. Prod., Pl. VIII, Fig. 1; Pl. IX, Fig. 1; and Pl. X, Fig. 1: also, Davidson, Salter, and others.

Producta Martini, Phillips, 1836, Geol. Yorks., Vol. II, p. 213, Pl. VII, Fig. 3: de Koninck, 1843, An. Foss. Carb. Belg., p. 160, Pl. VII, Fig. 2.

P——*pugilis*, Phillips, 1836, Geol. Yorks., Vol. II, p. 215, Pl. VIII, Fig. 6.

Leptæna antiquata, Fischer, 1837, Oryct. du Gouv. de Mosc., Pl. XXVI, Figs 4, 5.

L——*tubifera*, Fischer, 1837, ib., Pl. XXVI, Fig. 1. (Not Deshayes).

Productus Inca, d'Orbigny, 1842, Pal. Voy. dans l'Am. Mérid., Vol. III, p. 51; Pl. IV, Figs. 1-3.

P——*flexistria*, McCoy, 1844, Carb. Foss. Ireland, p. 109, Pl. XVII, Fig. 1.

P——*Calhounianus*, Swallow, 1858, Trans. St. Louis Acad. Sci., I, p. 181.*

Shell large, subquadrangular in outline, usually longer than wide, sometimes slightly transverse; hinge line equal to, or greater than the width at the middle of the shell, forming approximately a right angle with the lateral margins.

Ventral valve strongly arched from beak to front, beak large, incurved, scarcely passing the hinge line; sides of the umbo usually much compressed, rising almost perpendicularly from the large, slightly reflexed ears; central portion of the valve broadly flattened, usually with a broad, shallow sinus, beginning near the beak and extending to the front, from which central, flattened portion, the sides descend, with an abrupt slope, to the lateral margins.

Dorsal valve plane in the visceral region, becoming concave in the marginal portions, which are closely applied to the ventral valve, following its curves; middle of valve slightly elevated towards the front.

Surface of both valves ornamented by regular, rounded ribs, about 1 mm. in width, increasing by occasional bifurcation,

* The above synonymy is adopted from Mr. Meek, Final Report of Geol. Sur. of Nebraska, p. 160.

and separated by shallow, rounded grooves, equal in width to the ribs; visceral portion crossed by numerous, irregular, concentric wrinkles, most prominent on the ears, producing a finely reticulated appearance. From the summit of the ribs arise, at intervals of from 1 to 3 mm., very delicate, tubular spines, equally distributed over all parts of the shell.

In the interior of the ventral valve the elegantly sculptured ocluser impressions occupy a slightly raised, elongated, quadrangular space in the middle of the valve, extending nearly as far forward as the reticulations of the exterior. Each scar is long, narrow, and rounded at the extremities, the two being separated by a depressed groove. Outside of, and longitudinally parallel with the oclusors are the large, ovate, coarsely striated divaricator impressions.

In the dorsal valve the cardinal process is large, trilobed, united at the base with prominent lateral ridges, extending along the hinge line nearly to the cardinal extremities, and with a large mesial septum extending beyond the middle of the valve, and rising at the anterior extremity in a high, thin, narrow blade.

The ocluser impressions are large, rounded, and deeply sculptured. The reniform impressions extend out laterally from the anterior part of the muscular scars, for a considerable distance, then bend forward and terminate opposite the end of the septum. The thickened base of the cardinal process often shows a small and deep depression in the centre. The front of the valve is ornamented with large, spiny pustules, arranged irregularly in longitudinal rows.

Three examples measure:—

Length 65 mm.; width 63 mm.

“ 62 “ “ 57 “

“ 51 “ “ 60 “

The Brazilian forms of this species agree well with the Bolivian and North American forms, and with an European specimen from Visé, Belgium, loaned me from the Museum of Comparative Zoölogy. They differ markedly, however, from the other European specimens I have seen, in the char-

acter and arrangement of the spines. Several specimens having the spines attached, show that these were very fine, and regularly and closely disposed over the entire surface. The spine bases on the Visé specimen prove that its spiny covering was of a similar character. Other European specimens show the bases of spines, which are very few in number, irregularly disposed, and enormous in comparison with those of our specimens. Such forms are illustrated in de Koninck's *Monographie du Genre Productus*, Pl. IX, Fig. 1 *d*, and Davidson's *Mon. of Brit. Carb. Brach.*, Pl. XLIII, Figs. 1 and 1 *a*. The variety with large spines does not appear to have been described from America.

POSITION AND LOCALITY.—Coal Measures; abundant in the limestone at Bomjardim and on the beach at Itaitúba.

PRODUCTUS CORA (?), d'Orbigny, Pl. II, Fig. 17; Pl. VI, Fig. 17.

Productus Cora, d'Orbigny, 1842, *Pal. du Voy. dans l'Amér. Mérid.*, p. 55, Pl. V, Figs. 8, 9, 10.

Shell of moderate size, thin, wider than long; length of the hinge line equal to, or a little less than the width at the middle of the shell; lateral margins sinuous near the cardinal extremities, forming with the frontal margin a strong, and usually regular curve; front moderately produced, but without change of direction or curvature.

Ventral valve gibbous, without a sinus; beak pointed, extending but little beyond the hinge line; sides of the beak strongly curved, passing more or less abruptly into the large, wrinkled ears.

Dorsal valve more or less concave in the visceral region, the middle portion being somewhat depressed below the ears; geniculated towards the front, and closely applied to the ventral valve.

Surface marked by numerous, fine, regular, rounded, radiating costæ, separated by sulci of equal width, in which new ribs arise by intercalation. About ten ribs occupy the space of 5 mm. They sometimes become flexuous and irregular

near the margin, and also about the spines, two or three usually uniting at the base of each spine. Ears marked by several, large, angular, undulatory wrinkles, extending more or less towards the elevated, central portion of the ventral valve, but rarely crossing it. From the ears, just within the hinge margin, rise eight or ten delicate spines, while a few larger ones are scattered irregularly over the rest of the surface of the ventral valve. No traces of spines have been detected on the dorsal valve, on which the wrinkles continue across the middle of the valve.

In the interior of the ventral valve the muscular impressions are very faint. The indistinctly sculptured oclusors occupy an elevated, oval space just in advance of the beak, and the long, fan-shaped, longitudinally striated divaricators extend considerably beyond the anterior extremity of the oclusors, nearly to the middle of the valve.

In the dorsal valve the cardinal process is trifold, uniting at the base with prominent lateral ridges extending about half way to the cardinal extremities, and with a very slender mesial septum, that extends nearly to the middle of the valve. In one specimen the base of the process, instead of being solid, has a small and deep, circular pit in its centre. Muscular and reniform impressions not clearly shown.

Three specimens measure as follows:—

Length 29 mm.; width 34 mm.

" 23 " " 29 "

" 23 " " 25 "

The specimens from Brazil are much shorter and more transverse than the European specimens referred to d'Orbigny's species by de Koninck and Davidson, and none of them exhibit the prolonged front shown by their figures.

I have not attempted to give the synonymy of this species, for the reason that the Bolivian shell, which is the type of the species, does not appear to be sufficiently well known to enable one to determine with certainty the identity or distinctness of the numerous allied forms that have been named. D'Orbigny's figures are with good reason pronounced by

de Koninck to be bad, but as that author, who appears to have been the only one who has examined the original specimens, neglected to figure any of them, the European forms have come to be taken as types, though apparently differing as much from d'Orbigny's figures as some of the forms which are considered distinct by several palæontologists. If there are more than one species of the type of *P. Cora*, the characters which must be depended on for their separation are so obscure that, without authentic specimens or accurate figures of the original type, it is manifestly impossible to characterize them satisfactorily.

Toula, in his description of fossils from Cochabamba, Bolivia, mentions a shell which he identifies with doubt with *P. Cora*, d'Orb., but which he considers as distinct from the *P. comoides*, de Kon., which is the European shell referred to d'Orbigny's species. I hope soon to receive collections from Lake Titicaca which may help to clear up the confusion in which this form rests at present.

POSITION AND LOCALITY.—Coal Measures. This species occurs most abundantly in the small, whitish chert nodules at Itaitúba and Barreirinha, and in a similar rock given me by Sr. Gabriel Viera Lobos, of Obydos, and said to have been found on the lower part of the river Trombetas, a northern tributary of the Amazonas, just above Obydos. Associated with this species in the same rock was a *Discina*, and a lamellibranch common at Itaitúba. This species also occurs rarely in the large silicious boulders at Itaitúba, but has not been found in the limestone.

PRODUCTUS CHANDLESSII, sp. nov. Pl. IV, Figs. 1, 2, 3, 4, 7, 9, 10, 11, 13, 16; Pl. VI, Fig. 1.

Shell of moderate size, gibbous, variable in outline, usually transversely subquadrangular, length rarely equal to the width, hinge line equal to, or greater than the width at the middle; lateral margins sinuous near the hinge, meeting the broadly rounded frontal margins with a sharp curve.

Ventral valve more or less geniculated, varying considerably in shape from the greater or less elevation of the umbonal region above the hinge line; front moderately produced; median sinus usually present, shallow, distinct near the middle of the valve, but nearly obsolete at the front; beak of moderate size, slightly incurved over the hinge line; umbo depressed, rising but little above a plane cutting the hinge line perpendicular to the plane of the margin, or gibbous and strongly elevated above such a plane; sides of umbo somewhat compressed, rounding off sharply into the large, twisted ears.

Dorsal valve flat or slightly concave in the visceral region, geniculated towards the front, the reflexed portion being closely applied to the ventral valve; usually with a slight fold in the middle, corresponding to the sinus of the opposite valve.

Surface of visceral region of ventral valve reticulated, marked by a number of small, irregular, concentric wrinkles, intersecting with radiating costæ of moderate size, that become obsolete slightly in advance of the reticulated portion of the valve. Scattered irregularly over the surface are numerous, large, erect, hollow spines, of which four or five arise from the ears, and twenty or thirty are distributed over the rest of the valve. On most of the specimens the spines appear to have been broken off and the scars cicatrized. Ornamentation of the dorsal valve similar to that of the ventral; the costæ are, however, continued almost or quite to the front. About six spines, considerably smaller than those of the other valve, are disposed along the hinge line on each side of the beak, and numerous others are scattered irregularly over the surface.

In the interior of the ventral valve the sculptured ocluser impressions occupy an elevated, oblong, mesial ridge, extending some distance in advance of the beak. On each side of these, and longitudinally parallel with them, are the large, coarsely striated, fan-shaped divaricator impressions.

In the dorsal valve the cardinal process is trifid on the ex-

ternal face, but bifid on the internal, united with prominent lateral ridges, extending along the hinge to the cardinal extremities, and with a small, thin mesial septum that terminates in an elevated blade near the centre of the valve. The elongated, sculptured, occlusor impressions are raised above the septum on each side. From the anterior extremity of the muscular scars the broad reniform impressions extend at first outward, then bend forward and terminate opposite the end of the septum.

The following are measurements of three examples:—

Length, 27 mm. ; width, 32 mm. ; thickness, 11 mm.

“ 27 “ “ 27 “ “ 11 “

“ 29 “ “ 35 “

This species varies greatly in shape and convexity, and the extreme forms might be considered distinct if they were not connected by intermediate ones. One of the extreme forms (Pl. VI, Fig. 1) strikingly resembles *P. horridus*, Sow., in shape, though differing in ornamentation. The peculiar character of its ornamentation places it in the group called *Sublævi* by Davidson, including the species *P. mesolobus*, Phillips, *P. plicatilis*, Sow., and *P. sublævis*, de Koninck. Our species, however, differs in very obvious characters from all those just named.

POSITION AND LOCALITY.—Coal Measures. This is one of the most abundant fossils at Itaitúba, occurring in the limestone, silicious boulders, and on the beach. Mr. Chandless, the distinguished English traveler to whom it is respectfully dedicated, discovered this with other fossil Brachiopods about 100 miles south-west of Itaitúba, at Pedra de Barco, on the Parauary', a branch of the Maué-assú. A beautiful specimen received from him, and represented on Pl. IV, Fig. 13, leaves no doubt as to its identity with the Itaitúba forms, and judging from his description of the locality, the bed from which it was obtained is identical with that of Bomjardim.

PRODUCTUS BATESIANUS, sp. nov. Pl. I, Figs. 2, 10, 11, 12, 13, 15; Pl. II, Fig. 14; Pl. VI, Figs. 4, 7, 9.

Shell of moderate size, transversely subrectangular in outline; hinge line equal to greatest width, sometimes slightly extended in small, acute ears; lateral margins subparallel, almost straight nearly to the front, where they bend abruptly into the slightly sinuous frontal margin.

Ventral valve gibbous, geniculated, the posterior portion being nearly flat and rising almost perpendicularly, sometimes with a slight forward inclination, from the plane of the margins. Near the middle, the valve bends nearly at right angles, the curvature of the anterior portion decreasing rapidly near the front, which is often considerably produced. Sinus deep and wide, beginning broadly a little in advance of the beak, and extending, with but little increase of depth and width, to the front; beak broad and flat, scarcely rising above the general surface of the valve, terminating in a small, pointed apex, not incurved. A well defined, narrow area, with subparallel sides, exists under the beak, and extends to the cardinal extremities.

Dorsal valve very slightly concave in the visceral region, leaving a comparatively large body cavity; geniculated near the front, the marginal portion being closely applied to the ventral valve; middle of anterior portion marked by a slight fold corresponding to the sinus of the opposite valve.

Surface of the ventral valve ornamented by indistinct, flattened, radiating costæ, most prominent in the visceral region, becoming obsolete near the front. Visceral region often crossed by a few, faint, irregular, concentric wrinkles. Four or five large, tubular spines are distributed over the surface, as follows: one near each ear, one or sometimes two, in or near the sinus, near the front, and one, on each side, about midway between the one on the ear and the one near the sinus. Occasionally one or more of these spines is duplicated, and on some specimens there are half cicatrized scars that indicate that a second series of spines, similar to the one described,

had been broken off in the growth of the shell. ' The ornamentation of the dorsal valve is similar to that of the ventral, with the exception that no spines have been observed.

In the interior of the ventral valve the occlusor impressions occupy a raised, elongated, median ridge, extending forward about a third of the length of the valve; outside of this ridge are the large, coarsely striated, fan-shaped divaricator impressions, which do not extend forward of the occlusors.

In the dorsal valve the large cardinal process is obscurely lobed; the septum, and the muscular and reniform impressions are similar to those of *P. Chandlessii*.

Length, 22 mm.; width 28 mm.; thickness 11 mm.

" 19 " " 23 "

" 23 " " 23 "

This species resembles *P. sinuatus*, de Koninck, in general form and in the possession of an area, but the visceral region is not nearly so much depressed as in that species, and the ears and arrangement of the spines are quite different. The disposition of the spines in our species is quite peculiar, but though shown in a number of specimens, it may not prove constant in larger collections.

The ornamentation is quite similar to that of *P. Chandlessii*, nob., though the concentric wrinkles are much less distinct. The deep sinus gives it a bilobed appearance resembling certain forms of *P. longispinus*, Sow., especially those to which Norwood and Pratten gave the names *P. wabashensis* and *P. splendens*. The ornamentation and area are sufficient to separate our species from those mentioned. Interiorly the dorsal valve does not differ materially from that of *P. sinuatus* and *P. longispinus* as illustrated by Davidson. In the ventral valve the arrangement of the muscular scars is like that of *P. sinuatus* and *P. semireticulatus*, and quite different from *P. longispinus*, in which the divaricator impressions extend considerably in advance of the occlusors.

Dedicated to Mr. Walter Henry Bates, the distinguished naturalist and Amazonian explorer.

POSITION AND LOCALITY.—Coal Measures; in the limestone at Bomjardim, and on the beach at Itaitúba.

PRODUCTUS RHOMIANUS, sp. nov. Pl. III, Figs. 20, 41, 42, 43, 44, 49.

Shell small, usually slightly transverse; hinge line equal to, or greater than the width at the middle of the shell, meeting the lateral margins nearly at right angles; lateral margins sinuous near the cardinal extremities, front broadly rounded.

Ventral valve gibbous, without sinus; front moderately produced; beak small, slightly incurved over the hinge line, umbo extending but little beyond the hinge, its sides being compressed and sharply separated from the comparatively large, reflexed ears. Surface ornamented by rather coarse, regular, occasionally bifurcating costæ, separated by grooves of rather less width, and of which seven or eight occupy a space of 5 mm. At intervals of from 2 to 4 mm. each rib bears a small, erect spine. Visceral portion indistinctly wrinkled.

Dorsal valve deeply and regularly concave, ornamented with ribs and spines, similar to those of the ventral valve. In the interior of the dorsal valve the cardinal process is trifid, uniting with a thread-like mesial septum, that extends beyond the middle of the valve, separating the elongated muscular impressions, from the anterior extremity of which the prominent reniform impressions extend obliquely outward and forward.

Three examples measure:—

Length 12 mm.; width 13 mm.

“ 11 “ “ 11 “

“ 10 “ “ 12 “

This pretty little species resembles more or less closely several similar forms found in North America, but it does not appear to be identical with any of them. Specimens in Prof. Hall's collection, from Alpine Dam, Des Moines Valley, Iowa, that are either *P. muricatus*, Norwood and Pratten, or the young of *P. nanus*, Meek and Worthen, are very similar to our specimens in form and ornamentation. The Brazilian form, however, though attaining a larger size than the types

of *P. nanus*, never shows the marginal frill characteristic of that species, and it differs from *P. muricatus* in being much less transverse than the typical form of that species, as well as in having the reniform impressions extending obliquely from the muscular scars, instead of laterally as in *P. muricatus*, *P. longispinus*, &c. In this respect our species resembles *P. fimbriatus*, Sow., much more nearly than it does any other species of the genus whose interior I have seen illustrated.

P. parvus, Meek and Worthen, has a much more inflated umbo than our species, and much finer ribs, of which about twice the number occur in the same space. The spines of that species are also much less numerous, and are confined to the ventral valve. Our specimens also resemble the shell figured by Davidson (Mon. Brit. Carb. Brach., Pl XXXII, Figs. 13 and 14), and referred with some doubt to *P. muricatus*, Phillips. That form has, however, a more inflated beak, with uncompressed sides, while the length of its hinge line is less than the greatest width of the shell. Moreover, if Phillips' species is only a variety of *P. costatus*, Sow., as Davidson thinks, the interior is quite different from that of our species.

Dedicated to Mr. R. J. Rhome, of Taperinha, near Santarém, Province of Pará, a gentleman whose interest in science promises important results for the natural history of the Amazonas.

POSITION AND LOCALITY.—Coal Measures; from the limestone at Bomjardim, and on the beach at Itaitúba.

PRODUCTUS WALLACIANUS, sp. nov. Pl. III, Figs. 46, 47, 48; Pl. VI, Fig. 5.

Shell small, thin, subelliptical in outline, length and breadth about equal, usually slightly transverse; length of hinge line equal to the width at the middle of the shell; lateral margins strongly curved; front rounded.

Ventral valve ventricose or gibbous, without a sinus; umbo strongly arched, and usually much inflated; beak small, the sides being somewhat compressed, only the pointed extremity

overlying the hinge line; ears of moderate size, slightly reflexed, passing more or less rapidly into the swell of the umbo.

Dorsal valve strongly concave, following closely the curves of the ventral valve.

Surface of both valves without ribs or wrinkles, thickly covered with small, erect spines, more or less regularly arranged in quincunx order, at a distance from each other of about 2 mm.

In the interior of the dorsal valve the cardinal process is bifid, uniting with prominent, rounded lateral ridges, extending along the hinge line, and with a very slender mesial septum that extends nearly to the middle of the valve. Muscular impressions quadruple, the inner pair elongated, triangular, separated by the septum; outer pair triangular, shorter than the inner pair, and placed opposite its posterior portion. From between the muscular scars arise the reniform impressions, that extend outward and forward beyond the end of the septum, the space between the two impressions being granulose.

Four specimens measure as follows:—

Length 17 mm.; width 18 mm.

"	15	"	"	17	"
"	17	"	"	17	"
"	16	"	"	19	"

In the absence of ribs and wrinkles, and in the close arrangement of its spines, this species differs from any known to me in the American Carboniferous rocks. In these characters our species recalls some of the Devonian forms, for which Prof. Hall has proposed the name *Productella*, while in the interior of the dorsal valve, the quadruple muscular scars and the form of the reniform impressions resemble the corresponding parts in *Strophalosia*. Our species is perhaps more nearly related to *P. spinulosus*, Sow., than to any other Carboniferous form. It differs, however, from that species in being less transverse, and in being destitute of wrinkles on the ears. The spines likewise differ in not arising from elongated tubercles as in that species.

Dedicated to Dr. Alfred Russell Wallace, one of the most distinguished of Amazonian explorers.

POSITION AND LOCALITY.—Coal Measures; limestone at Bomjardim and beach at Itaitúba.

PRODUCTUS CLARKIANUS, sp. nov. Pl. VI, Fig. 6,; Pl. IX, Figs. 12, 13.

Shell small, thin, transversely subelliptical in outline; hinge line equal to the greatest width of the shell.

Ventral valve gibbous, without sinus, beak somewhat inflated, the pointed extremity slightly overlying the hinge line; ears large, strongly wrinkled.

Surface marked by fine, rounded ribs, that increase by bifurcation, and at frequent intervals become swollen, giving rise to slender spines, that are directed forwards. Near the front sixteen ribs occur in a space of 5 mm. The entire surface is also marked with numerous, prominent, undulating, concentric wrinkles, that present a short, almost perpendicular slope towards the beak, with a longer and more gradual slope towards the front, they being most strongly developed on the ears and front of the valve.

Length 14 mm.; width 20 mm.

This species, in the character of its ornamentation, closely resembles *P. undatus*, DeFrance, and may be considered as the American representative of that species. Our species differs from specimens of *P. undatus*, from Visé, in the de Koninck collection, in its much finer costæ and more irregular, but less prominent and angular, concentric ridges. The peculiar terraced appearance of *P. undatus* is not shown on our species. *P. undatus* is described and figured with small ears, and the length of the hinge line is less than the greatest width; *P. Clarkianus* has, on the contrary, an extended hinge line, and ears that are enormous in comparison with the size of the shell. Specimens from Kansas Territory in Maj. Hawm's collection, labeled *P. boonensis*, Swallow, somewhat resemble our species, but the costæ are coarser, the ears not

so large, and the concentric wrinkles are indistinct towards the front of the valve, while on the same part of our species the wrinkles are more distinct than on the visceral portion of the valve. Prof. Swallow states that his species resembles closely *P. spinulosus*, Sow., a form quite distinct from the Brazilian and Kansas specimens in question. Mr. Wm. Gurley, student in the Geological Laboratory, has shown me specimens collected by him from the Coal Measures at Danville, Ill., which agree in every respect with our species.

This interesting species has been dedicated to Mr. Jno. S. Clarke, of Boston, one of the most prominent patrons of the expedition of '71.

POSITION AND LOCALITY.—Coal Measures. This species occurs very rarely in the white, decomposed cherts at Itaitúba, and in the limestone at Bomjardim.

Genus CRANIA, Retzius.

Specimens of a species of this genus occur in the limestone of Bomjardim, but are too few and imperfect for specific determination.

Genus DISCINA, Lamarck.

Specimens of one or more species of *Discina* were found in the decomposed cherts of Itaitúba, and in the rock from the Rio Trombetas, containing *Productus Cora*, mentioned on page .

COMPARISON OF THE CARBONIFEROUS BRACHIOPOD FAUNA OF SOUTH AMERICA WITH THAT OF NORTH AMERICA.

Of the twenty-seven species of Brachiopoda described above, twelve are identified with forms occurring in North America. Of these twelve, eight, viz.: *Athyris subtilita*, *Eumetria punctulifera*, *Spirifera camerata*, *S. opima*, *S. perplexa*, *S. planoconvexa*, *Chonetes glabra* and *Productus Cora*, are, in

North America, considered to be characteristic of the Coal Measures. Of the remaining four, one, *Productus semireticulatus*, ranges through the entire Carboniferous system, and the other three were, heretofore, known only from the Chester limestone. Of these last, *Spiriferina spinosa* is a doubtful form, the Brazilian specimens being too poor to allow of a satisfactory determination; our specimens of *Spiriferina transversa* stand intermediate between the forms of the species found in the Chester limestone and the Coal Measures species, *S. kentuckensis*; and the specimens identified by Prof. Hall with the Chester limestone species, *Athyris sublamellosa*, are very similar to the Permian form *A. pectinifera*, Sow., and may perhaps unite the two species into one having an extended vertical range. The occurrence of the Genus *Strophalosia* also indicates affinities with the Permian. The majority of the new species are more nearly related to forms occurring in the Coal Measures than to those of any other formation of North America, though some of them are most nearly related to European species. *Orthis* (?) *Morganiana* and *Streptorhynchus Hallianus* may be particularly mentioned as showing strong affinities with Coal Measures forms.

The Carboniferous Brachiopods from other localities in South America are apparently of the same age. From the Pichis River locality I have recognized the four Coal Measures species mentioned on pages 6 and 7; the other two species, though not determinable specifically, clearly belong to Coal Measures types. The species described by d'Orbigny from Lake Titicaca and Yarbichambi, Bolivia, though usually referred to the Subcarboniferous, are identical with, or closely allied to Coal Measures forms from Brazil and North America. The following species appear to be identical: *Athyris subtilita*,* *Spirifera camerata*,† *Productus*

* *Spirifer Roissyi*, d'Orb. (*Terebratula peruviana*, on plate); identified with *A. subtilita*, Hall, by Salter (Quart. Jour. Geol. Soc., Vol. 17, p. 64).

† *Spirifer Condor*, d'Orb. Mr. Meek writes me that he considers the identity of *Spirifer Condor* and *S. camerata* very doubtful. He would most probably separate the two on account of the distinct concentric lamellæ shown in d'Orbigny's figures of the former species, since he states on p. 184 of the Final Report of the Geol. Sur. of Neb. that this character is never seen on *S. camerata*. Several of our specimens,

longispinus,* *P. Villiersi*, *P. boliviensis* and *Leptaena* [*Chonetes*] *variolata*.† The following species have closely allied forms in the North American Coal Measures: *Terebratula Andii*, d'Orb.,‡ *T. Gaudryi*, d'Orb.,‡ and *Productus Humboldtii*, d'Orb.§ Of the remaining six species described by d'Orbigny, two are united with *Productus semireticulatus* by European palæontologists, leaving four, viz.: *Spirifer Pentlandi*, *Orthis Cora*, *Orthis Buchii* and *Productus Andii*, whose affinities are as yet undetermined.

From the province of Arque, a degree or more south-east of Lake Titicaca, Col. Lloyd obtained the following species: || *Spirifer Condor* [*camerata*], *S. lineatus*, *Productus Cora*, *P. Inca* [*P. semi-reticulatus*], *P. boliviensis* and *Orthis Andii*.

From Santa Cruz Mr. Cummings obtained the following species: || *Terebratula millepunctata* [*T. bovidens*], *Rhynchonella peruviana*, *R. pleurodon* (?), *Spirifer boliviensis* and *S. Condor* [*camerata*].** From Cochabamba, lying between Santa Cruz and Lake Titicaca, Toula†† has identified the following forms:

which, by the way, were identified with *S. camerata* by Prof. Hall, show the lamellæ very distinctly, though their presence is by no means a constant character. Fig. 14, Pl. I, shows one of these forms. Toula gives excellent figures of a *Spirifer* from Cochabamba, agreeing in every respect with our specimens of *S. camerata* from Brazil, which he identifies with d'Orbigny's species and refers to *S. striatus*, Martin.

* *Productus Capacii*, d'Orb., identified with *P. longispinus* by de Koninck, Davidson and others.

† The last three species were identified from the Coal Measures of the Western States by Norwood and Pratten (Jour. Acad. Nat. Sci., Phil., 1854),

‡ These two species are placed by Mr. Meek in the Genus *Syntrilasma*, and are closely related specifically with the typical species, *S. hemiplicata*, Hall.

§ Compared by Owen and Meek with the characteristic Coal Measures species, *P. nebrascensis*, Owen. It has also been identified by Mr. Davidson (Quart. Jour. Geol. Soc., Vol. 18, p. 32) from India, where it is associated with a number of species which are, in North America, considered to be characteristic of the Coal Measures.

|| Forbes, Bolivia and Peru, Quart. Jour. Geol. Soc., Vol. 17, p. 50.

** Of the above, *Rhynchonella peruviana* and *Spirifer boliviensis* belong to types which, according to Salter, may be either Devonian or Carboniferous. The other species of *Rhynchonella* is referred with doubt to *R. pleurodon* by Salter. It is nearly allied to, if not identical with *R. Uta*, Marcou (*R. osagensis*, Swallow), to which it is referred with doubt by Mr. Meek (Final Rep. Geol. Sur. of Neb., p. 179). Toula refers the same form from Cochabamba to *R. pleurodon*, but states that it is probably identical with *Terebratula* [*Rhynchonella*] *Uta*, Marcou.

†† Ueber einige Fossilien des Kohlenkalkes von Bolivia. Aus d. LIX Bde. d. Sitzb. d. Kais. Akad. d. Wissensch., I Abth. März-Heft, Jahrg. 1869.

Terebratula Hochstetteri, Toula,* *Athyris subtilita*, *Spirifera camerata*,† *Spiriferina octoplicata*, Sow.,‡ *Rhynchonella Uta*, (?),§ *Orthis resupinata*, var. *latirostrata*, Toula||, *Productus Cora*,** *Chonetes tuberculata*, McCoy, *Chonetes mucronata*, Meek and Hayden [*C. granulifera*, Owen], and *Chonetes glabra*, Geinitz.

From this review, which includes all the species of Brachio-poda known from the Carboniferous of South America, it appears that only the Coal Measures period of that age has as yet been determined. In the southern part of Brazil, in the provinces of Rio Grande do Sul and Santa Catharina, there are Carboniferous beds of same age containing workable beds of coal and characteristic coal plants.††

* Probably the same as the form from Santa Cruz identified by Salter with *T. millepunctata*. Toula's figures are excellent, and leave but little doubt as to its identity with the North American form *T. bovidens*, Morton.

† *Spirifer striatus*, var. *multicostatus*, Toula. See note, p. 61.

‡ No figure is given of this form. It is said to differ somewhat from the species with which it is identified, and it is perhaps quite as likely to prove identical with one of the Brazilian or North American Coal Measures species.

§ *R. pleurodon*, Toula, see note, p. 62.

|| This is said to be the same as *Orthis Cora*, d'Orb. Its identity with *O. resupinata*, Martin, appears doubtful.

** Only a single example of this species was obtained, and no figure is given of it. The author remarks: "Auf der grösseren Klappe sind regelmässig angeordnete Stachelspuren sichtbar, welche dieses Individuum von *Productus camoides*, de Koninck unterscheiden, den er später selbst als *Productus Cora*, d'Orb., bezeichnet und Taf. V, Fig. 2 (Animaux Fossiles) abbildet."

†† Hartt, Geology and Physical Geography of Brazil, p. 519. 1870.

NOTE.—The photographic plates illustrating this article have been printed on plain paper with great care, by ~~M. G. F. Hartt~~, the Photographic Laboratory of the University, and it is believed that they will be found to be permanent.

CH. FRED. HARTT.

PLATE I.

(Figures of Natural Size.)

Page.

SPIRIFERA CAMERATA.

13

- FIG. 1. Cardinal view of an unusually elongated specimen, (Bomjardim.)
- FIG. 3. Dorsal view of a specimen in which the outer silicified crust is broken away, showing the muscular impressions on the inner crust, (Bomjardim.)
- FIG. 6. Ventral view showing muscular impressions and pustules on the inner silicified surface, (Bomjardim.)
- FIG. 9. Ventral view of a specimen in which the fasciculated arrangement of the ribs is quite indistinct, (Bomjardim.)
- FIG. 14. Ventral view of a specimen with prominent concentric lamellæ, (Bomjardim.)

SPIRIFERA OPIMA.

15

- FIG. 4. Interior of a ventral valve from the limestone of Paredaó.

ATHYRIS SUBTILITA.

7

- FIG. 5. Ventral view, (Bomjardim.)
- FIG. 7. Dorsal view, (Bomjardim.)
- FIG. 8. Ventral view showing the spire, (Bomjardim.)

PRODUCTUS BATESIANUS.

54

- FIG. 2. Dorsal view, (Bomjardim.)
- FIG. 10. Ventral view showing spine bases, (Bomjardim.)
- FIG. 11. Dorsal view showing the hinge area, (Bomjardim.)
- FIG. 12. Ventral view, (Bomjardim.)
- FIG. 13. " " "
- FIG. 15. " " "





PLATE II.

(*Figures of natural size.*)

Page.

TEREBRATULA ITAITUBENSIS.

1

- FIG. 1. Cast of a ventral valve, (from silicious boulders at Itaitúba).
 FIG. 3. Cast of the interior of a dorsal valve, showing the two pairs of ridges, (from silicious boulders at Itaitúba).
 FIG. 8. Cast of the interior of a dorsal valve, showing the two pairs of ridges and the thin scale filling the space between the crural plate and the bottom of the shell, (from silicious boulders at Itaitúba).
 FIG. 16. Ventral view of an internal cast, (from silicious boulders at Itaitúba).

ATHYRIS SUBLAMELLOSA.

10

- FIG. 9. Ventral view of an unusually elongated, globose specimen of this species, (beach at Itaitúba).
 FIG. 10. Dorsal view of a slightly crushed specimen, (beach at Itaitúba).
 FIG. 11. Ventral view, " "
 FIG. 12. Ventral view of an unusually large specimen, showing a faint sinus. The inner silicified surface shows the muscular impressions and the cavity enclosed by the dental plates, (beach at Itaitúba).

SPIRIFERA CAMERATA.

12

- FIG. 2. Dorsal view showing muscular impressions, (beach at Itaitúba).
 FIG. 15. Slab containing two specimens of this species, (beach at Itaitúba).

SPIRIFERA OPIMA.

15

- FIG. 7. Dorsal view of an internal cast, (from silicious boulders at Itaitúba).

SPIRIFERINA TRANSVERSA.

21

- FIG. 4. View of a specimen with a high area, (beach at Itaitúba).
 FIG. 5. Ventral view, " "
 FIG. 6. Dorsal view, " "
 FIG. 13. Fragment of a very elongated specimen, " "

PRODUCTUS BATESIANUS.

54

- FIG. 14. View from the beak showing the muscular impressions of the ventral valve, (beach at Itaitúba).

PRODUCTUS CORA.

49

- FIG. 17. Interior of a dorsal valve, (decomposed cherts).





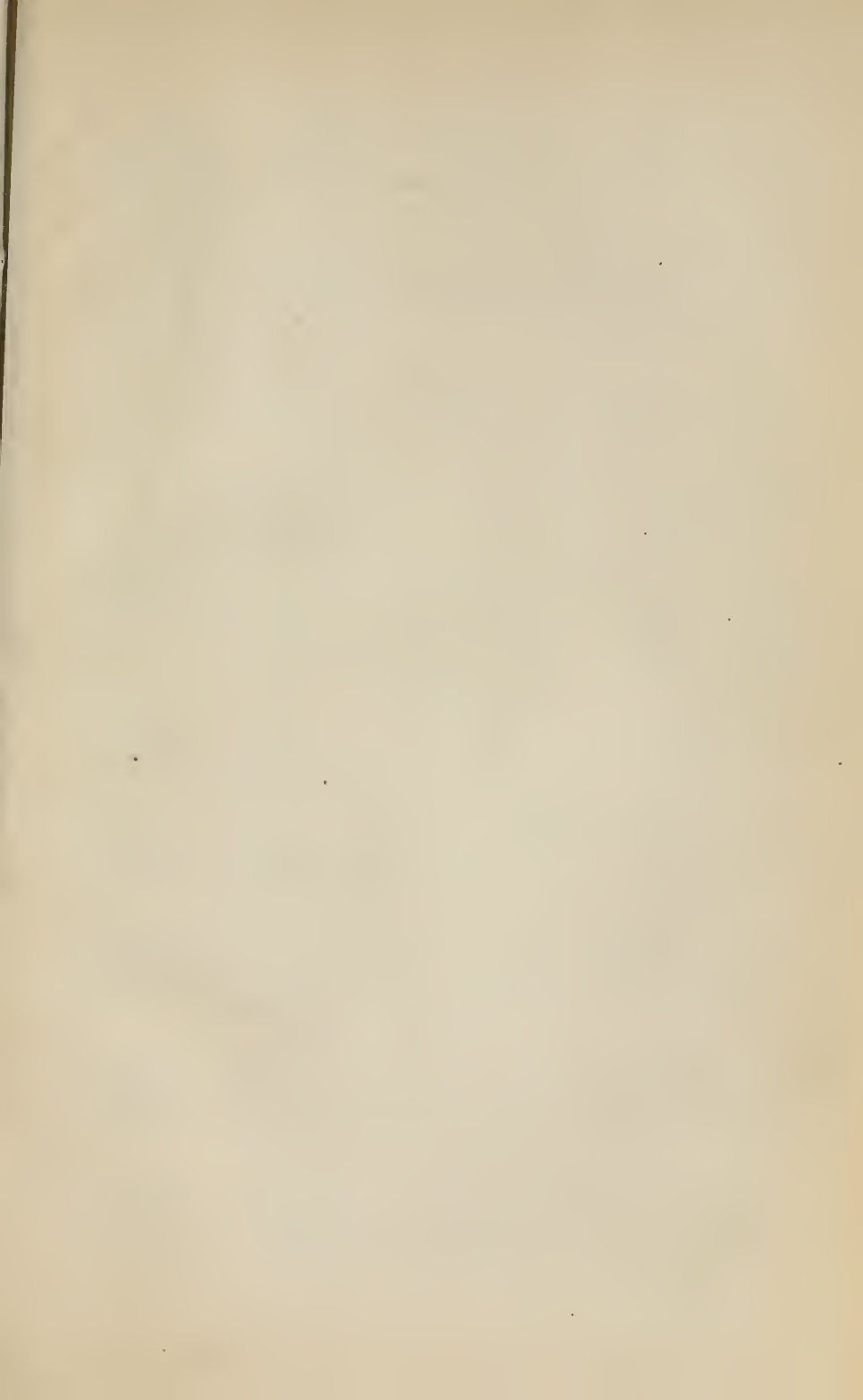


PLATE III.

(*Figures of specimens from Bomjardim, all of natural size*).

Page.

ORTHIS (?) MORGANIANA.

29

FIGS. 1, 2, 3, 4 & 5. Interiors of dorsal valves, showing muscular impressions, cardinal process, etc.

FIGS. 6, 7, 9 & 11. Interiors of the ventral valves, showing the three lamellæ and the muscular impressions.

FIG. 34. Interior of a dorsal valve.

SYNTRILASMA HEMIPLICATA.

FIG. 10. Interior of the ventral valve of a specimen from Nebraska City, introduced for comparison with *Orthis* (?) *Morganiana*.

ATHYRIS SUBTILITA.

7

FIG. 8. Interior of the rostral portion of the shell showing the crural plate of the dorsal valve, together with the articulation of the valves.

FIG. 16. Interior of a ventral valve with the cardinal portion of the dorsal valve articulating with it. The beak is broken away, causing the light spot in the centre.

FIG. 19. Interior of a dorsal valve, showing cardinal process and septum.

ATHYRIS SUBLAMELLOSA.

10

FIG. 15. Dorsal view.

FIG. 21. Ventral view.

FIG. 29. Dorsal view.

TEREBRATULA ITAITUBENSIS (?).

1

FIG. 24. Dorsal view of a specimen which is either the young of this species, or an undetermined form.

WALDHEIMIA COUTINHOANA.

3

FIG. 22. Dorsal view of a slightly distorted specimen.

SPIRIFERA (MARTINIA) PERPLEXA.

16

FIG. 27. Dorsal view.

FIG. 39. Interior of a dorsal valve. The curved line within the beak is a fracture. The muscular impressions are too faint to appear in the figure.

FIG. 40. Ventral view.

FIG. 45. Ventral view showing on the left side the delicate spines.

FIG. 50. Interior of a ventral valve showing muscular impressions.

SPIRIFERINA TRANSVERSA.

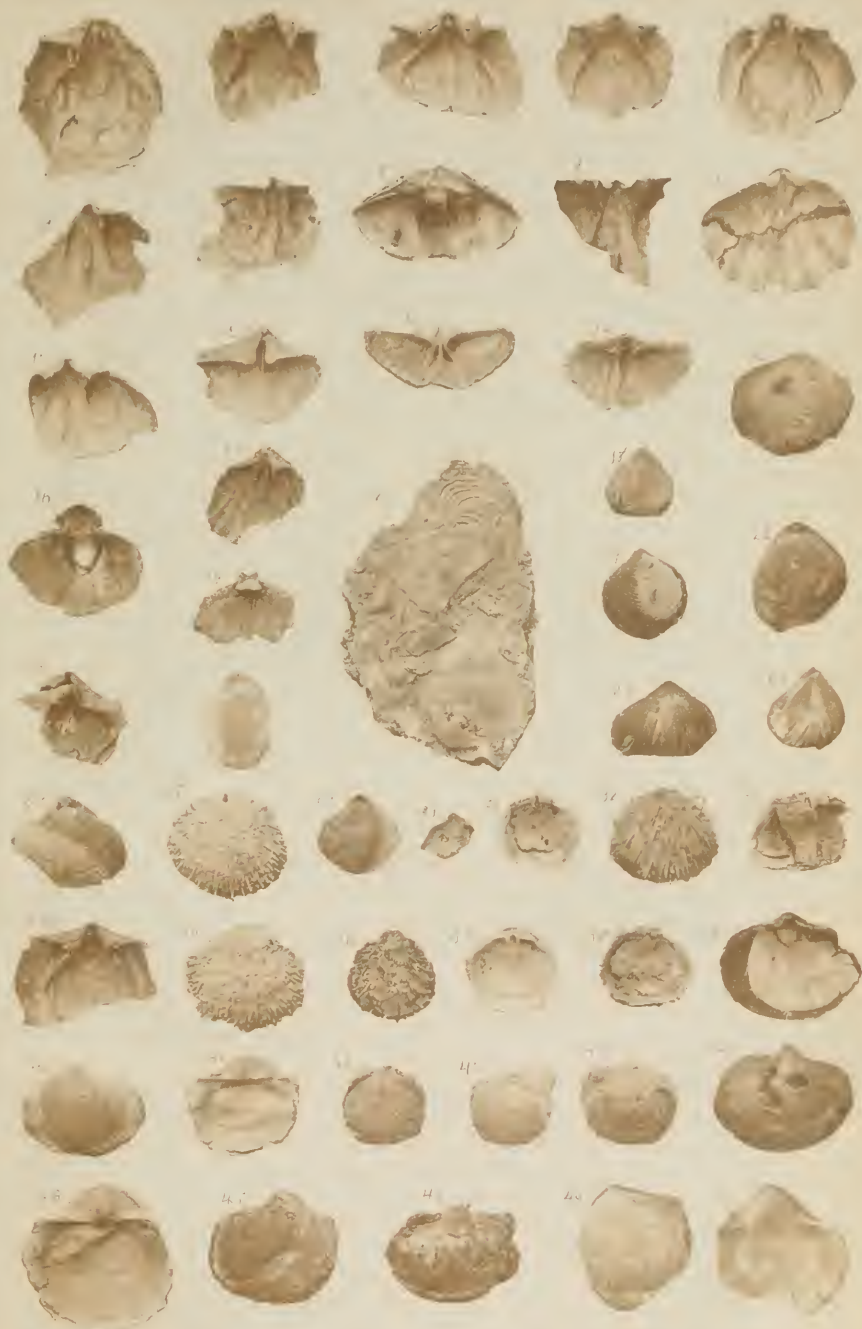
21

FIG. 12. Interior of a ventral valve.

FIG. 13. " " " "

FIG. 14. Interior of a dorsal valve.

FIG. 17. " of a fragment of a ventral valve.





RHYNCHONELLA PIPIRA.

24

- FIG. 18. Ventral view of a small specimen.
 FIG. 23. Two ventral valves of this species fitted together. Both show the foramen, triangular fissure and teeth.
 FIG. 25. Dorsal view of a moderately large specimen.
 FIG. 26. Dorsal view of a somewhat distorted specimen.
 FIG. 31. Interior of the beak of a ventral valve.

STROPHALOSIA CORNELLIANA.

45

- FIG. 28. Exterior of a ventral valve, the beak smooth from attachment to some foreign body.
 FIG. 30. Dorsal view of a specimen with united valves.
 FIG. 32. Exterior of a ventral valve showing the arrangement of the spines.
 FIG. 33. Elongated specimen with the valves united, showing the articulation of the valves.
 FIG. 35. Exterior of a ventral valve.
 FIG. 36. " " " "
 FIG. 37. Interior " " "
 FIG. 38. Dorsal view of a specimen with united valves.

PRODUCTUS RHOMIANUS.

56

- FIG. 20. Fragment of rock showing dorsal valve of this species, together with *Orthis Penniana* and other fossils. The upper figure shows the details of the interior of the dorsal valve.
 FIG. 41. Dorsal view of a specimen in which the central portion is obscured by the matrix.
 FIG. 42. Interior of a dorsal valve showing the reniform impressions.
 FIG. 43. Ventral view.
 FIG. 44. " "
 FIG. 49. Ventral view of the largest specimen of this species yet found.

PRODUCTUS WALLACIANUS.

57

- FIG. 46. Dorsal view.
 FIG. 47. Ventral view.
 FIG. 48. Interior of a dorsal valve showing muscular and reniform impressions.

PLATE IV.

(Figures of natural size).

Page.

PRODUCTUS CHANDLESSII.

51

- FIG. 1. Dorsal view of a transverse specimen. (Bomjardim).
 FIG. 2. Interior of a ventral valve. (Bomjardim).
 FIG. 3. Ventral view. (Bomjardim).
 FIG. 4. " " "
 FIG. 7. Interior of a dorsal valve. This figure and figure 4 represent the separated valves of the same specimen.
 FIG. 9. Interior of a dorsal valve. The margin is partially broken and obscured in the matrix. In front of the shell is a fragment of a *Strepatorhynchus*. (Bomjardim).
 FIG. 10. Interior of a dorsal valve. (Bomjardim).
 FIG. 11. Ventral view of a specimen in which the outer silicified surface is broken, exposing the inner surface bearing the muscular impressions. The oclusors occupy the groove in the centre of the upper part of the figure. The divaricators, being in the shade, are not very distinctly shown. (Bomjardim).
 FIG. 13. Ventral view of a specimen collected by Mr. Chandless at Pedra de Barco on the river Parauari. The costæ on this specimen are unusually prominent, and extend rather farther forward than in the majority of the specimens.
 FIG. 16. Ventral view of an elongated form very much elevated in the umbonal region. (Bomjardim).

SPIRIFERA CAMERATA.

13

- FIG. 5. Interior of a ventral valve with several specimens of *Strophalosia Cornelliana* attached. The muscular impressions in this specimen are unusually long and narrow. (Bomjardim).

SPIRIFERA OPIMA.

15

- FIG. 12. Exterior of a ventral valve. (Bomjardim).

ORTHIS (?) MORGANIANA.

29

- FIG. 6. Ventral view of a nearly regular specimen. (Bomjardim).
 FIG. 14. Dorsal view of a globose, distorted specimen. (Bomjardim).
 FIG. 15. Profile " "

PRODUCTUS SEMIRETICULATUS.

47

- FIG. 8. Exterior of a ventral valve showing the character and arrangement of the spines. (Bomjardim).





PLATE V.

(*Figures of specimens from Bomjardin, all of natural size*).

Page

STREPTORHYNCHUS HALLIANUS.

35

- FIG. 1. Interior of a ventral valve, showing the area, teeth and muscular impressions.
- FIG. 2. Exterior of a ventral valve.
- FIG. 5. Exterior of a dorsal valve.
- FIG. 8. Interior of a dorsal valve. The cardinal process of this specimen is straight and projects in such a manner as to be much foreshortened in the figure. It agrees with the process represented in figure 18, in every respect, except direction.
- FIG. 12. Fragment of a dorsal valve showing the hinge line and the posterior face of the septum.
- FIG. 16. The same.
- FIG. 14. Fragment of a ventral valve on which the costae are arranged in large plications at the margins. Fig. 2 shows the same character in a less degree.
- FIG. 18. Interior of a dorsal valve.

STREPTORHYNCHUS TAPAJOTENSIS.

37

- FIG. 3. Ventral view.
- FIG. 6. Dorsal view of a specimen with an unusually long, distorted beak.
- FIG. 7. Interior of a ventral valve.
- FIG. 9. Interior of a dorsal valve.
- FIG. 10. Dorsal view of a nearly symmetrical specimen.

ORTHIS PENNIANA.

26

- FIG. 13. Dorsal view of a large specimen with a sinus.
- FIG. 15. Interior of a dorsal valve.
- FIG. 17. " " " "
- FIG. 19. Ventral view of a large specimen.
- FIG. 20. Dorsal view.
- FIG. 21. Posterior view of a large and thick specimen.
- FIG. 22. Interior of a ventral valve.
- FIG. 23. Interior of a dorsal valve.

EUMETRIA MORMONII.

4

Prof. Marcou informs me that his *Geology of North America*, in which this species is described and figured as *Terebratulina Mormonii*, was published and distributed in February, 1858. As Dr. Shumard's paper was read March 8 of the same year, and printed and distributed some time afterwards, Prof. Marcou's name clearly has preference over *E. punctulifera*, Shumard, which has been used in the text.

- FIG. 24. Interior of a ventral valve showing the teeth, area and foramen.

SPIRIFERA CAMERATA.

12

- FIG. 11. Interior of a dorsal valve.

SPIRIFERINA TRANSVERSA.

2

- FIG. 4.] Interior of a dorsal valve.







PLATE VI.

(Figures of natural size).

Page.

TEREBRATULA ITAITUBENSIS.

I

FIG. 15. Interior of a dorsal valve, (silicious boulders at Itaitúba).

ATHYRIS SUBTILITA.

7

FIG. 2. Cast of the interior of a ventral valve showing the muscular impressions and beak cavity, (beach at Itaitúba).

ATHYRIS SUBLAMELLOSA.

10

FIG. 16. Ventral view showing muscular scars, etc., on the cast of the interior.
(beach at Itaitúba).

SPIRIFERINA SPINOSA (?).

23

FIG. 8. Exterior of a dorsal valve, (decomposed cherts).

FIG. 13. Dorsal view of an internal cast, (decomposed cherts).

FIG. 14. Ventral view of an internal cast showing the septum, (decomposed cherts).

STREPTORHYNCHUS TAPAJOTENSIS.

37

FIG. 10. Exterior of a large dorsal valve, (beach at Itaitúba).

STREPTORHYNCHIUS CORREANUS.

32

FIG. 11. Gutta percha cast of the area of a specimen of this species, (silicious boulders).

CHONETES AMAZONICA.

41

FIG. 3. Cast of the interior of a ventral valve, with casts of the prolongations of the cardinal spines through the substance of the shell, (decomposed cherts).

FIG. 12. Portion of a cast of a ventral valve, (decomposed cherts).

FIG. 19. Cast of a ventral valve, (decomposed cherts).

PRODUCTUS CHANDLESSII.

51

FIG. 1. Specimen of this species resembling *P. horridus*, Sow., (beach at Itaitúba).

PRODUCTUS BATESIANUS.

54

FIG. 4. Exterior of a ventral valve, (beach at Itaitúba).

FIG. 7. " " " " " "

FIG. 9. Cast of the interior of a ventral valve, (beach at Itaituba).

PRODUCTUS WALLACIANUS.

57

FIG. 5. Exterior of a ventral valve, (beach at Itaitúba).

PRODUCTUS SEMIRETICULATUS.

47

FIG. 18. Interior of a fragment of a dorsal valve, (beach at Itaitúba).

PRODUCTUS CORA.

49

FIG. 17. Exterior of a ventral valve in white chert. A worm tube (?) passing under the front margin of the shell appears like a spine.

PRODUCTUS CLARKIANUS.

59

FIG. 6. Internal cast of a ventral valve of this species in white decomposed chert. The large ear on the left side is distinctly shown in the figure.

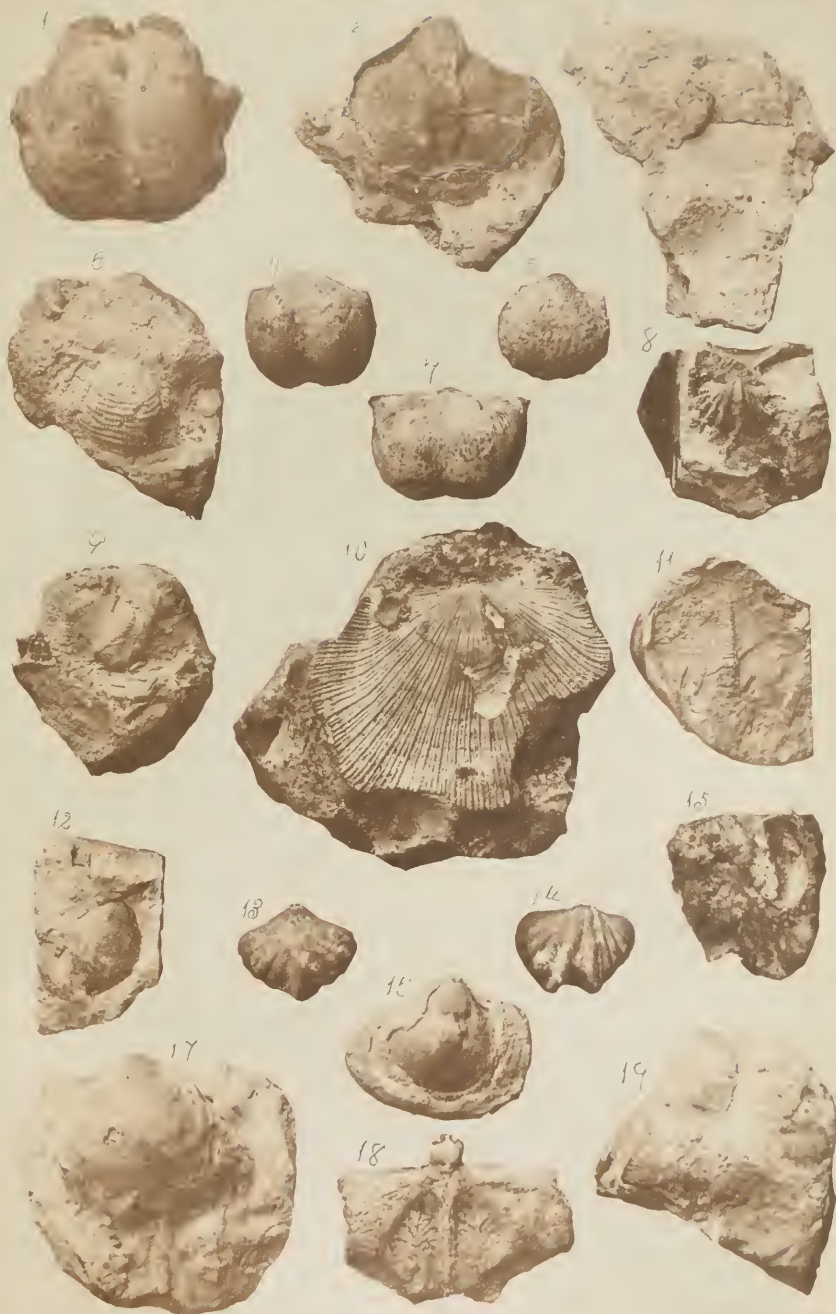




PLATE VII.

(Figures of one-half natural size).

Page.

STREPTORHYNCHUS CORREANUS.

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- FIG. 1. Cast of the interior of a ventral valve (silicious boulders).
- FIG. 2. Cast of the interior of a dorsal valve. " "
- FIG. 3. Cast of the exterior of a ventral valve. " "
- FIG. 4. Cast of the interior of a ventral valve. " "
- FIG. 8. Cast of the area of a ventral valve. " "
- FIG. 10. Posterior view of a cast of the interior of a ventral valve, (silicious boulders).
- FIG. 11. Dorsal view of an internal cast, (silicious boulders).
- FIG. 12. Cast of the interior of a ventral valve, (silicious boulders).
- FIG. 13. Cast of the interior of the area, " "
- FIG. 14. Cast of the interior of the dorsal valve, " "
- FIG. 17. Cast of the interior of the ventral valve, " "

STREPTORHYNCHUS SENILIS.

- FIG. 9. Cast from Visé, Belgium, labelled "*Orthis Senilis* Phillips" in De Koninck's handwriting. The cast of the cardinal process is similar to that shown on several specimens of *S. Correanus*. This specimen was loaned me from the Museum of Comp. Zoöl., Cambridge, Mass.

PRODUCTUS SEMIRETICULATUS.

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- FIG. 5. Interior of a dorsal valve, (Bomjardim).
- FIG. 6. Exterior of a ventral valve, (beach at Itaitúba).
- FIG. 7. Internal cast of a ventral valve, showing muscular impressions, (beach at Itaitúba).
- FIG. 15. Exterior of a ventral valve, (beach at Itaitúba).
- FIG. 16. A group of the spines of this species, from the beach at Itaitúba.

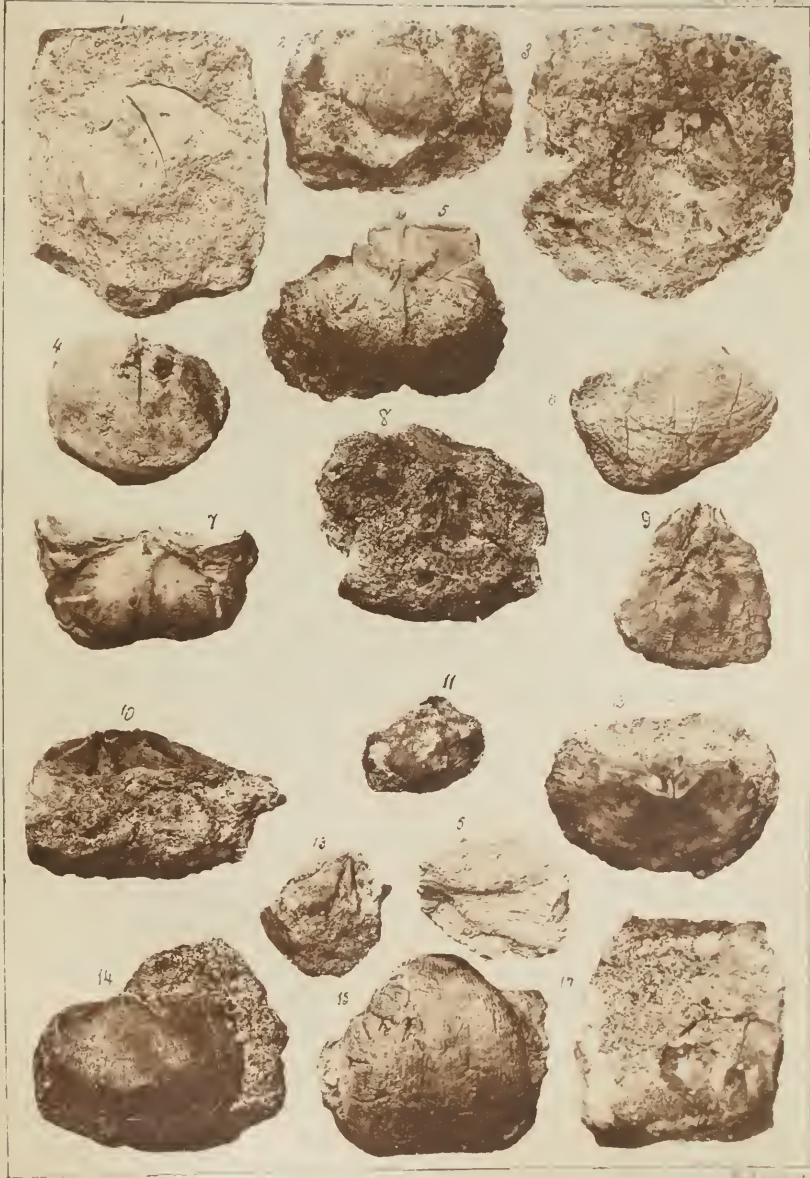






PLATE VIII.

(Figures of natural size).

Page.

WALDHEIMIA COUTINHOANA.

3

FIG. 6. Ventral view of a young specimen, (Bomjardim).

EUMETRIA MORMONIL.

4

(*E. punctulifera* Shumard in the text; see explanations to plate V.)

FIG. 4. Dorsal view, (Bomjardim).

FIG. 5. Profile " "

FIG. 7. Dorsal " "

FIG. 8. Dorsal view, (Pichis River, Peru).

FIG. 10. Dorsal view, (Bomjardim).

SPIRIFERA (MARTINIA) PLANOCONVEXA.

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FIG. 12. Dorsal view, (Bomjardim).

FIG. 16. Ventral view, " "

FIG. 18. Dorsal view, " "

SPIRIFERA (MARTINIA) PERPLEXA.

16

FIG. 13. A young specimen of this species seen from the beak, introduced for comparison with *Spirifera planoconvexa*, (Bomjardim).

ORTHIS PENNIANA.

26

FIG. 2. Ventral view of a small specimen, (Bomjardim).

STREPTORHYNCHUS HALLIANUS.

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FIG. 3. Interior of a small dorsal valve, (Bomjardim).

STREPTORHYNCHUS TAPAJOTENSIS.

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FIG. 9. Exterior of a ventral valve, (Bomjardim).

CHONETES GLABRA.

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FIG. 11. Exterior of a ventral valve, (Bomjardim).

FIG. 14. " " " " "

FIG. 15. Interior " " " "

FIG. 19. Dorsal view of a specimen with united valves, (Bomjardim).

STROPHALOSIA CORNELLIANA.

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FIG. 1. Interior of a ventral valve; the muscular marks are very indistinctly shown, (Bomjardim).

FIG. 17. Interior of a ventral valve, (Bomjardim).





PLATE IX.

(*Figures of natural size*).

WALDHEIMIA COUTINHOANA.

3

FIG. 1. Interior of a specimen of this species seen from the dorsal side. The loop is supported by a piece of cork near the front of the shell. (Bomjardim).

FIGS. 2 & 2a. Interiors of the beak, showing the dental plates of the ventral valve and the crural plate of the dorsal, (Bomjardim).

EUMETRIA MORMONII.

4

FIGS. 3 & 3a. Interiors of the dorsal valve. In 3a the projecting finger-like process is broken. (Bomjardim).

ATHYRIS SUBTILITA.

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FIG. 4. Crural portion of the loop with accessory lamellæ. (Bomjardim).

FIG. 4a. Crural portion of the spires with a portion of the accessory lamellæ. (Bomjardim).

ATHYRIS SUBLAMELLOSA.

10

FIG. 5. Perfect specimen of the spires of this species. (Bomjardim).

FIG. 6. Portion of a dorsal valve showing the perforated hinge plate, (beach at Itaitúba).

SPIRIFERA (MARTINIA) PLANOCONVEXA.

19

FIG. 7. Interior of a dorsal valve. (Bomjardim).

FIG. 7a. " " " " " "

FIG. 7b. " " " " " "

FIG. 7c. " " ventral " " "

FIG. 7d. " " " " " "

CHONETES AMAZONICA

41

FIG. 8. Gutta percha mould from a cast of the interior of a dorsal valve. The muscular and reniform impressions are shown on one side, (decomposed cherts).

FIG. 9. Gutta percha mould from a cast of a ventral valve, (decomposed cherts).

STROPHALOSIA CORNELLIANA.

45

FIG. 10. Interior of a dorsal valve, showing muscular and reniform impressions. The cardinal process in this specimen is broken. (Bomjardim).

FIG. 11. Interior of a perfect dorsal valve. (Bomjardim).

PRODUCTUS CLARKIANUS.

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FIG. 12. Exterior of a ventral valve, (Bomjardim).

FIG. 13. " " " " " "

STREPTORHYNCHIUS TAPAJOTENSIS.

37

FIG. 14. Interior of the dorsal valve of a young specimen, (Bomjardim).

FIG. 15. " " " " " " " "

FIG. 17. " " " " " " " "

STREPTORHYNCHIUS HALLIANUS.

35

FIG. 16. Ventral valve of a young specimen of this species, (Bomjardim).



Phot. L. A. C. V.

